THE WEATHER AND CIRCULATION OF DECEMBER 1958[1]

RAYMOND A. GREEN

Extended Forecast Section, U.S. Weather Bureau, Washington, D.C.

1. GENERAL CIRCULATION

Waves of large amplitude characterized the mean circulation at middle latitudes of the Western Hemisphere during December 1958 (fig. 1). At the same time fast westerlies in waves of small amplitude dominated the Eastern Hemisphere at similar latitudes. Just the opposite was true in November when large amplitudes prevailed over the Eastern Hemisphere with the remainder of the pattern rather zonal [1]. In December deep mean troughs extending from the Aleutians to Hawaii and from the Maritime Provinces to the Gulf of Mexico were separated by a strong ridge over western North America. For the most part these systems lay well within climatologically favored areas as outlined in the study by Klein and Winston [2]. At middle latitudes these mean waves were amplified counterparts of systems already existing in November (fig. 5 of [1]).

A comparison of the field of changes in mean 700-mb. height anomaly from November to December (fig. 2A) with the December pattern (fig. 1) helps to delineate the areas of greatest amplification; namely, the east-central Pacific, western and southeastern United States, and the west-central and northeastern Atlantic. Large changes from Great Britain to northwestern Siberia accounted for the flattening of an extensive November ridge over Europe. The two months differed markedly at high latitudes where a huge anticyclone (470 ft. above normal) dominated the December pattern (fig. 1). This system was centered about 400 miles poleward from the northern tip of Alaska and was the most intense in 12 Decembers of record for that section of the Arctic. The surrounding channel of negative height departures from normal (frequently found around blocking Highs) was far from uniformly intense, and its displacement from the high center varied greatly. A strong ridge connection was maintained toward a second blocking High near Greenland, and a weaker southward extension of positive anomalies damped the Asiatic coastal trough. A third connection through western Canada and United States attended amplification of the normal pattern to an extensive mean ridge (also at sea level, Chart XI) which markedly affected United States weather.

Mean wind speeds at the 700-mb. level (fig. 3A) were strongest at middle latitudes of the Pacific and the Atlantic. The belt of maximum mean westerlies curved northeastward from the central Pacific with diminishing speeds to northwestern United States, then southeastward with increasing speeds to a maximum centered in the western Atlantic. Numerous Alberta waves traversed paths paralleling, but northward from, the axis of the main branch of maximum westerlies over North America (see Chart X). Several daily anticyclones (Chart IX) followed a track nearly coincident with the path of a secondary wind maximum from western Canada to the Dakotas, then southeastward along the main wind branch to the Atlantic.

Greatest positive departures from normal of mean wind speed (fig. 3B) were located in middle latitudes of the Pacific and the Atlantic. A smaller center appeared over the Northern Plains at the confluence between the main branch of maximum westerlies and a secondary branch from Canada. Large negative areas associated with high-latitude blocking were centered near Iceland, the Aleutians, and just east of Hudson Bay.

After a dip in early December, the 5-day mean index of the strength of the temperate westerlies recovered rapidly during the first week and remained above normal to exceed the monthly average of November. This made the eighth consecutive month with above normal values of the zonal index. However, the classical association of high index with predominantly warm, zonally oriented temperature anomalies over the United States did not apply this month (Chart I–B).

2. CIRCULATION CHANGE RELATED TO UNITED STATES TEMPERATURE ANOMALY

Temperature anomalies in December 1958 changed much more from November than the 1932 to 1954 average determined by Namias [3]. For that period he found the November to December change averaged more than one class out of five at only 33 percent of the stations. In 1958 the changes exceeded one class at 68 percent of the representative stations. Figure 2B illustrates the distribution, direction, and magnitude of the changes, with mainly warming to the west and cooling to the east of the Continental Divide.

Several interrelated circulation characteristics favored these changes of the temperature anomaly pattern. Increased 700-mb. heights (fig. 2A) over Alaska and the Yukon, coupled with strengthened northerly flow across

[1] See Charts I–XVII following p. 492 for analyzed climatological data for the month.

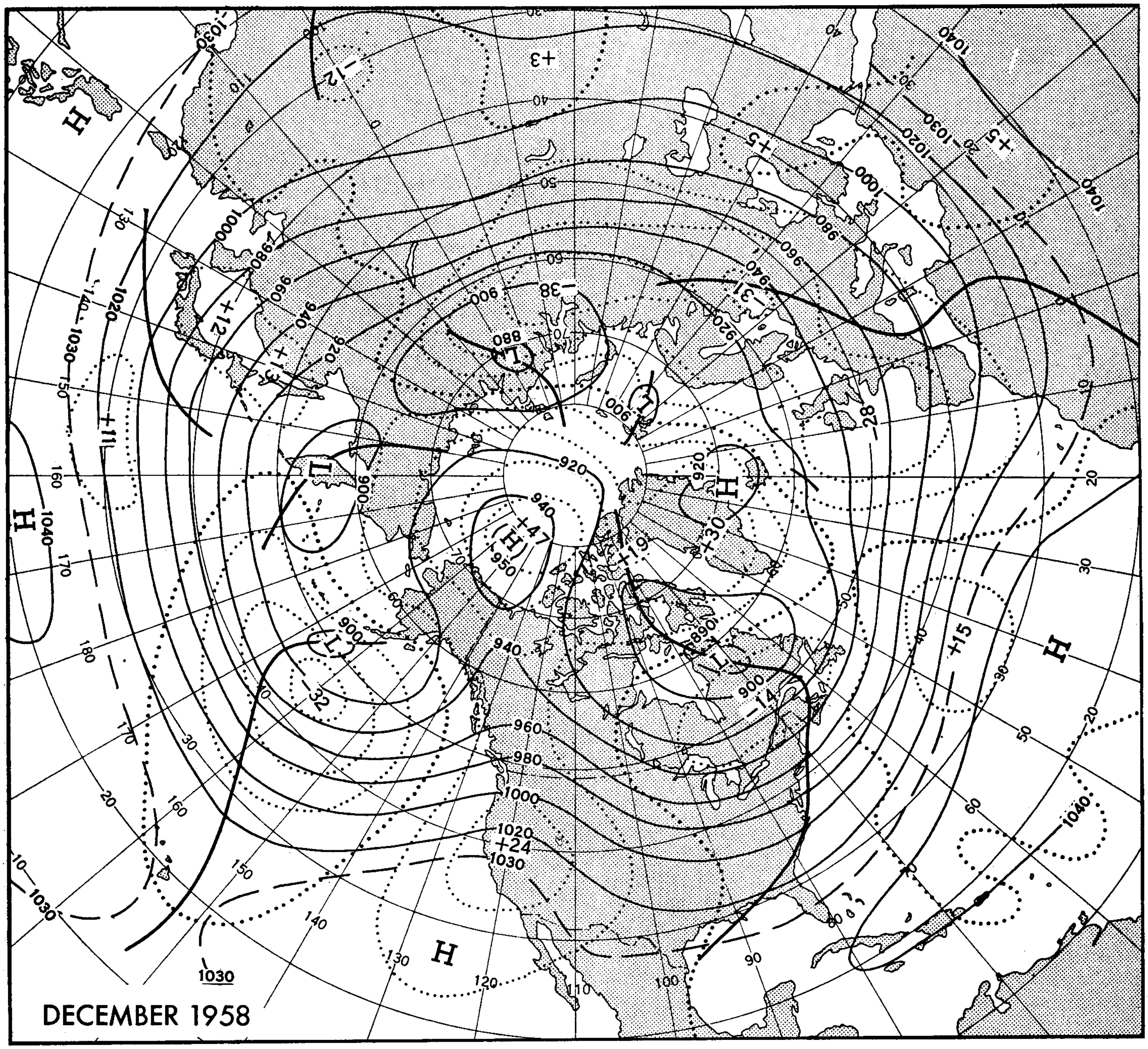


FIGURE 1.—Mean 700-mb. contours (solid) and height departures from normal (dotted), both in tens of feet, for December 1958. Troughs are indicated by heavy lines. Middle-latitude waves with strong amplitudes were surmounted by high-latitude anticyclones in the Western Hemisphere.

a cold source, enhanced cooling over central and eastern United States. Lowered 700-mb. height anomalies accentuated the effect of these factors over the eastern States where the greatest cooling occurred. Most of the warming must be attributed to the local effect of increased 700-mb. height anomalies attending anticyclogenesis west of the Divide.

Temperature records for extremes of both cold and warmth for December were broken in the areas just described. New records for cold were set by the mean monthly temperature at Grand Rapids and Muskegon, Mich., Toledo and Akron, Ohio, and Allentown, Pa. Numerous stations east of a line from Louisville, Ky. to Sault Ste. Marie, Mich., recorded the coldest December since 1917, when December sea level activity [4] was very similar to that of 1958. Record warmth occurred at San Diego, Los Angeles, Burbank, San Francisco, Red Bluff, and Blue Canyon in California.

3. INTRA-MONTHLY VARIABILITY

A. CHANGES BETWEEN THE HALF-MONTHS

A crude evaluation of variability within the month was obtained from tracks (not shown) of 5-day mean 700-mb.

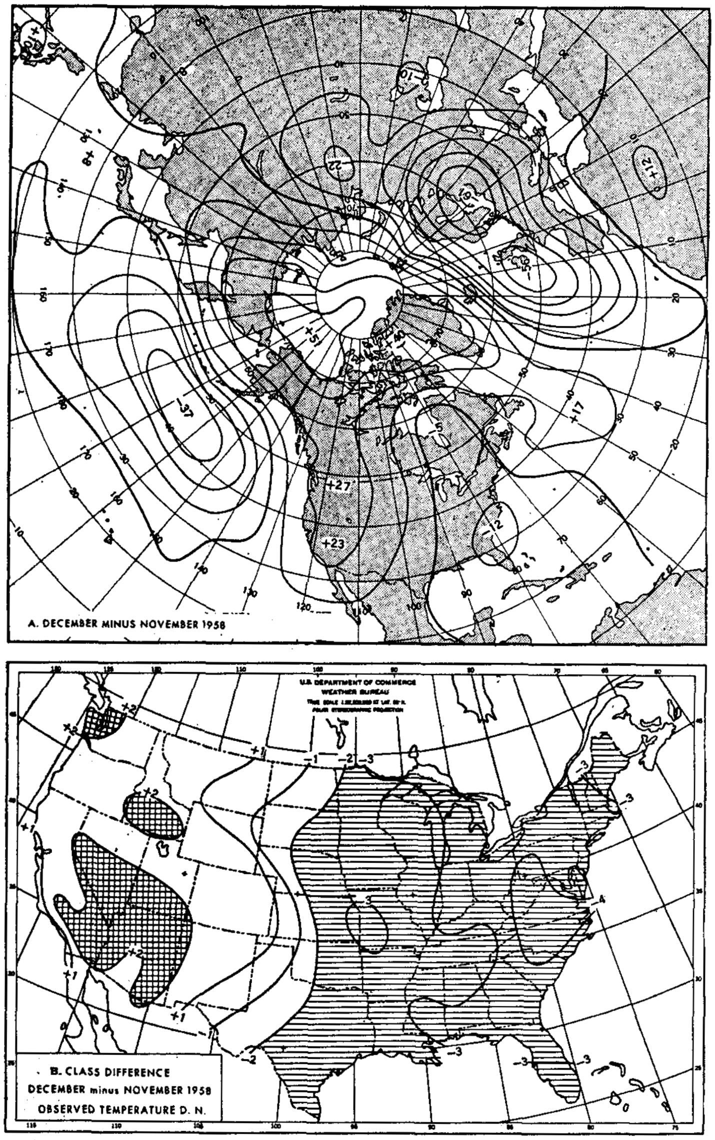


FIGURE 2.—(A) Difference (in tens of feet) between the mean monthly 700-mb. height departures from normal of November and December 1958. Greatest changes occurred over the Baltic Sea, near England, and north of Alaska. Middle-latitude changes in the Western Hemisphere amplified November systems. (B) The number of classes the surface temperature anomaly changed from November to December 1958. Warming in the West accompanied stronger cooling in the East.

height anomaly centers over the Western Hemisphere. Centers over and adjacent to North America were strong and relatively stationary during the first half-month, weaker and more transitory during the second. Figure 4A, a comparison of half-month means, brings to light the changes which modified earlier 700-mb. height and anomaly flow over much of the United States. There was tremendous alteration (−800 ft.) of the pattern over the Arctic Basin in the area occupied by the Arctic High. At the same time the wave in the eastern Pacific and North America lost some amplitude and (more important with respect to United States weather) moved eastward. Blocking became more pronounced over Greenland as the

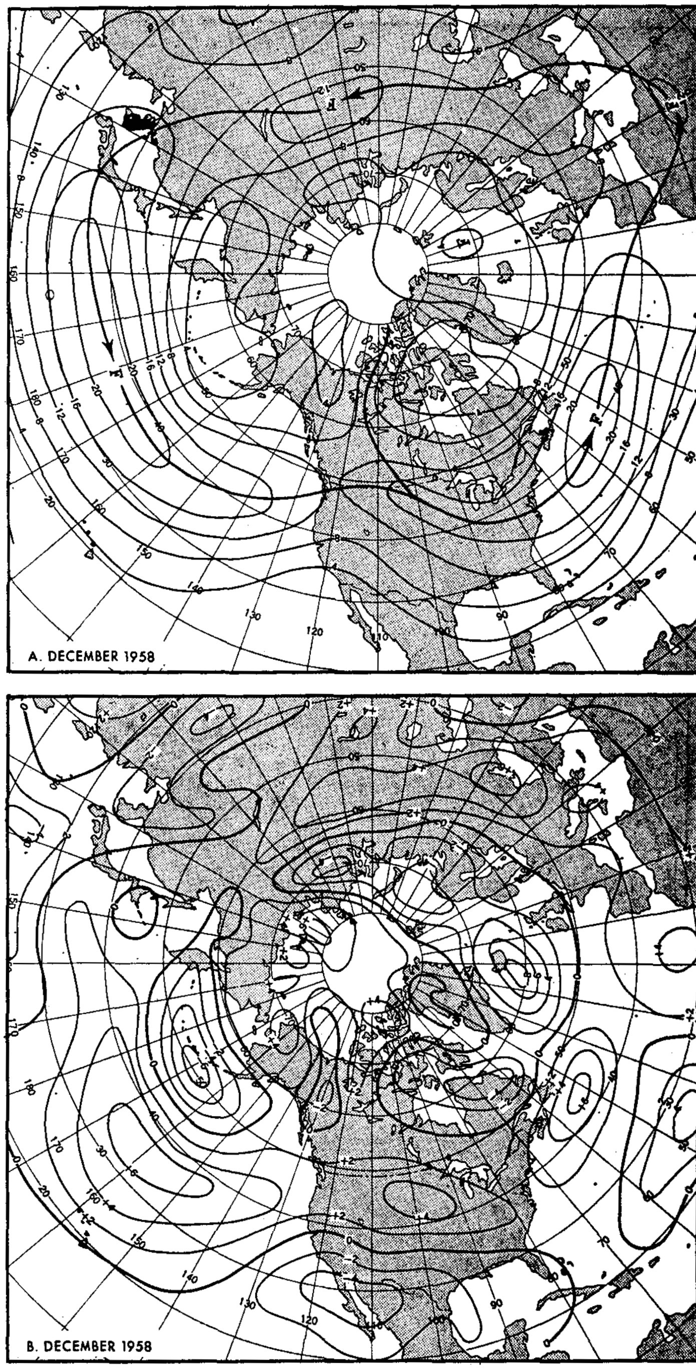


FIGURE 3.—(A) Mean isotachs (in meters per second) of 700-mb. wind speed during December 1958. Solid arrows indicate axes of maximum wind speed. Fastest winds occurred over the oceans at middle latitudes. (B) Departure from normal of mean 700-mb. wind speed. Greatest positive departures were found over the middle-latitude oceans, from the Black Sea to western Siberia, and over the Northern Plains of the United States. Strong negative areas associated with blocking appeared near Iceland, the Aleutians, and eastern Canada.

month progressed, and the Atlantic mean ridge was flattened.

Temperature anomalies in the United States reacted sharply as circulation characteristics favoring the warm-West-cold-East regime gave way to higher index condi-

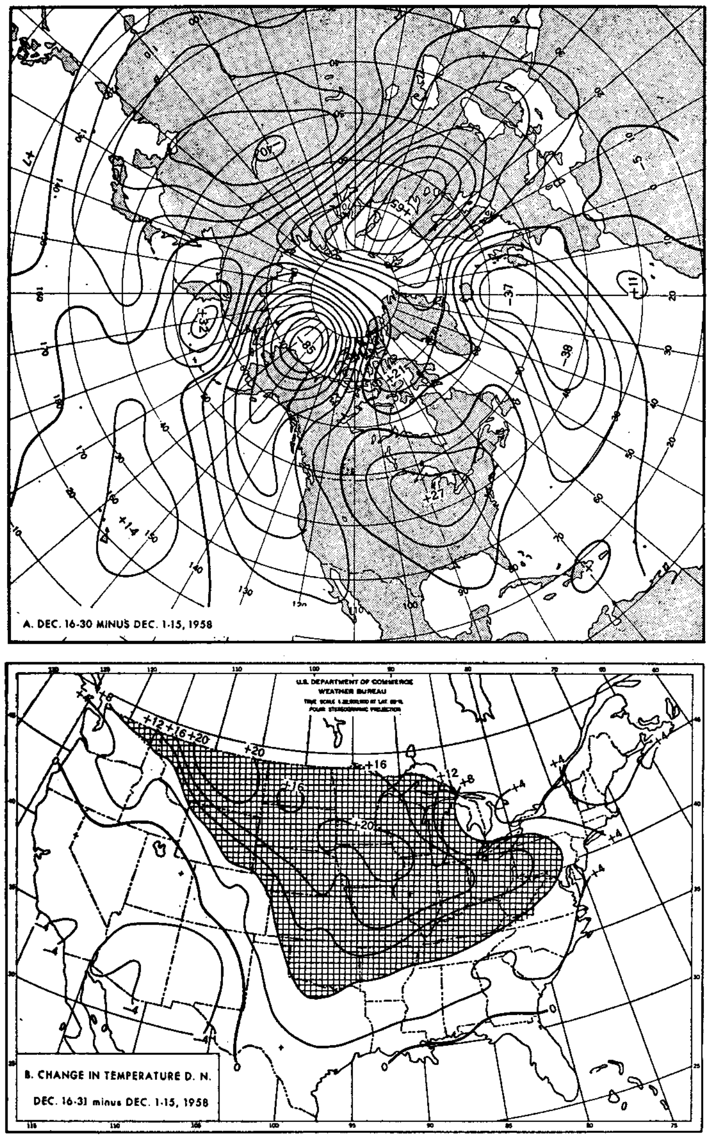


FIGURE 4.—700-mb. height change in tens of feet from December 1–15 to December 16–30, 1958. Large changes occurred in the Arctic High over the Beaufort Sea area, while blocking intensified over Greenland and Baffin Island. Changes in the eastern Pacific and the United States reflected eastward motion of the mean wave train. Height changes were associated with changes in the pattern of temperature anomaly (° F.) in the United States shown in (B).

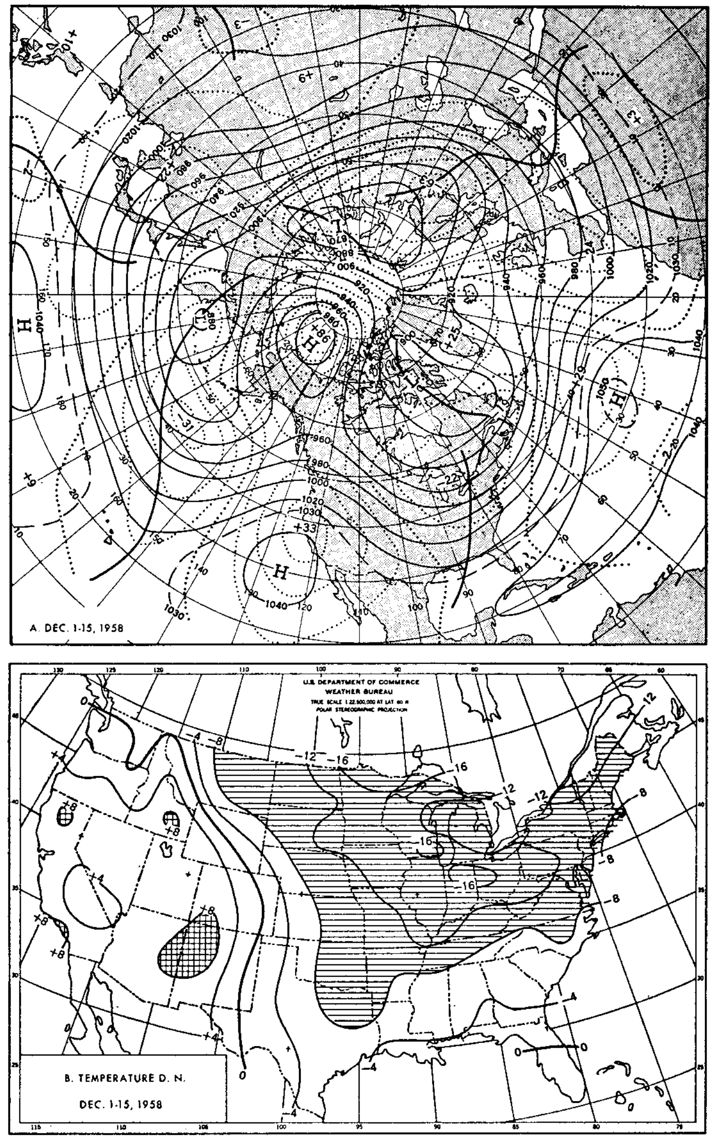


FIGURE 5.—(A) Fifteen-day mean 700-mb. height contours (solid) and departures from normal (dotted), both in tens of feet, for December 1–15, 1958. The Arctic High, the strong ridge over western North America, and the deep trough in the East helped to deploy cold Canadian air into the United States. (B) Mean United States temperature anomalies for December 1–15 (° F.).

tions. Part B of figure 4 shows the magnitude and extent of differences between temperature anomalies of the two half-months. There was close agreement between changes in surface temperature and 700-mb. height, especially where 700-mb. changes opposed earlier anomalous flow from the north in the area from Montana to Iowa. An interesting double maximum in this warmer area may have been related to foehn warming just east of the Divide. On the other hand, foehn warming diminished over parts of the Southwest, where cooler anomalies accompanied generally weaker anticyclonic circulation. Advective warming apparently counteracted the cooling influence of lowered 700-mb. height anomalies over the Pacific Northwest.

B. DECEMBER 1–15

A mean chart of the first fifteen days of December (fig. 5A) displays exaggerated (over mean December) versions of several features earlier described as differing most from November. The strongest system of this half-month was the Arctic High with an anomaly of +860 ft. at 700 mb. Positive anomalies projected strongly southward along a ridge over western North America and also toward Greenland. Mean troughs in the Pacific and the eastern United States were deep and the Atlantic ridge strong; the European ridge of November was no longer in evidence.

This half-month's pattern represented optimum conditions for flooding central and eastern United States with cold air; namely, high 700-mb. heights over Alaska and the Yukon and strong northerly anomalous and actual flow from Canada into a deep mean trough over the eastern United States. Part B of figure 5 depicts the extent and intensity of cold east of the Divide, where only a part of Florida experienced average temperatures above normal for the period. As the avalanche of cold air traversed the steep incline of maximum winds from western Canada to the Middle Atlantic States, daily temperature records tumbled in Iowa, Ohio, New York, Rhode Island, and Virginia. The first polar outbreak followed the last storm of a series of rather weak Alberta waves which were speeding across the Great Lakes during the first few days of the month. The final storm deepened over the Lakes and decelerated while cold air became firmly entrenched east of the Divide and deterred later storms until mid-month.

Abnormal warmth prevailed west of the Divide beneath a strong mean ridge with onshore flow of warm Pacific air. New daily maximum temperature records were established in New Mexico, Arizona, Nevada, and California.

C. DECEMBER 16–31

Most Western Hemisphere systems reflected higher index characteristics during the second half-month (fig. 6). The Arctic High vanished and a weak mean trough extended northward across western Alaska. The ridge over western North America, the downstream United States trough, and the Atlantic ridge at middle latitudes were all flatter and located eastward from positions of the preceding period. While the mid-latitude wave from the Pacific through the United States retained greater than normal amplitude, conditions favoring transport of Canadian air into the States were greatly modified. 700-mb. height anomalies increased east of the Divide as the ridge moved eastward and the anomaly gradient decreased and became more westerly.

Warmest temperature anomalies (fig. 6B) occurred over central Montana, where fast westerlies increased the foehn warming often observed in that section of the country. Temperatures continued below normal over the Great Lakes and southeast of a line from the Ohio Valley to western Texas. This area remained under the influence of northerly flow and near to below normal 700-mb. heights.

A new series of rapidly moving Alberta waves (Chart X) was established at mid-month. Most of these were somewhat stronger than the early December storms. Rather weak outbreaks of Canadian air penetrated eastern sections of the country between Lows, except for the final surge which ended the series. The last storm was similar to the final storm of the earlier Alberta series. It was deeper than its predecessor and moved northeastward from the Great Lakes instead of continuing to the Atlantic Coast. The polar anticyclone behind the storm dominated the weather of the eastern United States for three days beginning Christmas Day. As the anticyclone moved into the Atlantic, a wave from the Gulf of Mexico

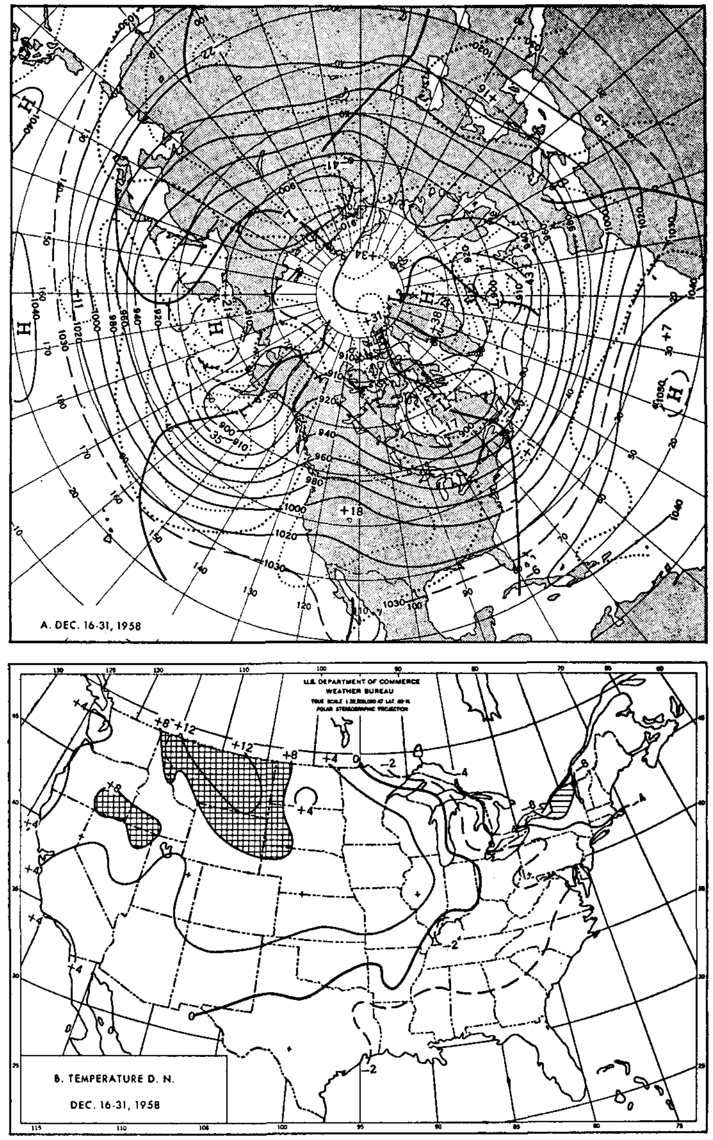


Figure 6.—(A) Sixteen-day mean 700-mb. height contours and departures from normal for December 16–31, 1958. Circulation over North America was flatter this half-month and temperature anomalies (B) considerably warmer than during the previous half-month shown in figure 5.

crossed Florida and moved inland from the South Atlantic coast before passing out to sea off the Virginia Capes. It was the first Gulf wave of several which crossed Florida during the month to re-enter the country. Copious precipitation accompanied the storm over the Carolinas and parts of Virginia.

4. PRECIPITATION

Precipitation exceeded normal in four general areas (Chart III-B), with greatest departures over the Pacific Northwest and the northern Divide. Large amounts west of the Divide (Chart II) can be attributed to the orographic lifting of fast westerlies, while a weak secondary storm track (Chart X) along the northern Divide helped to intensify lower-level upslope flow and precipitation east of the Divide. Since these depressed storms often follow strong polar outbreaks, it is not surprising that most of this precipitation fell during the first half-month. Similar conditions attended a late December storm over New Mexico and the Texas-Oklahoma Panhandle, depositing a record 12 inches of snow in 24 hours and a record 14.2-inch December total at Albuquerque, N. Mex.

More than 2 inches of precipitation fell during the month along the western Gulf coast and across several States in the Southeast, all associated with several Gulf waves (Chart X) along the mean trough (fig. 1). Heavier amounts in this area exceeded normal east of the mean trough in Florida, the Carolinas, and Virginia. In this area a snowstorm on the 11th deposited record falls of 16 inches at Elizabeth City, N.C. and 9.1 inches at Raleigh, N.C., and record 24-hour precipitation amounts of 3.44 inches were measured at Asheville, N.C. and 3.48 inches at Winston-Salem, N.C. from the 27th to the 28th.

The Great Lakes region contained two areas of abnormal precipitation. One of them, centered in Canada, covered just the northern tip of Michigan; the other made headlines when Oswego, N.Y. reported records of 33 inches of snow in 24 hours and a depth of 56 inches on the 8th. Less than a hundred miles away, Rochester, N.Y., with records dating to 1835, reported its driest December, as did Schenectady in eastern New York.

Dry conditions prevailed under the strong mean ridge over the Southwest, especially in Arizona and southern California where down-slope easterly flow prevailed on the mean sea level map (Chart XI) and in the pattern of 700-mb. height departure from normal (fig. 1). Phoenix and Tucson, Ariz., reported no December precipitation for the first time since 1917. Serious fire hazards due to drought existed over parts of southern California where Burbank tied its previous record for dryness with only a trace for the month. A mean sea level High was centered near Salt Lake City, where the driest 8 consecutive months on record brought a total in that period of only 2.54 inches. The mean sea level ridge and the absence of storms from South Dakota to Virginia were indicative of anticyclonic conditions and dry weather from the Dakotas to the Ohio Valley. Lowest December totals on record were measured at Fargo, N. Dak. and Indianapolis, Ind., and totals were the second lowest on record at stations in Minnesota, Nebraska, and Wisconsin.

On the whole, December was a dry month over the United States, as one might expect from its circulation and temperature patterns and its higher than normal zonal index. However, this was not a typical high index pattern, as evidenced by the meridional orientation of the temperature anomalies. More important factors affecting precipitation were the anticyclonic nature of the circulation over much of the United States and the lack of low-level flow into the United States from either of two important sources of moisture, the Gulf of Mexico and the Atlantic Ocean. There were no intense large-scale storms in the United States and only one report of a severe local storm was noted, a tornado at Sarasota, Fla., on December 11.

REFERENCES

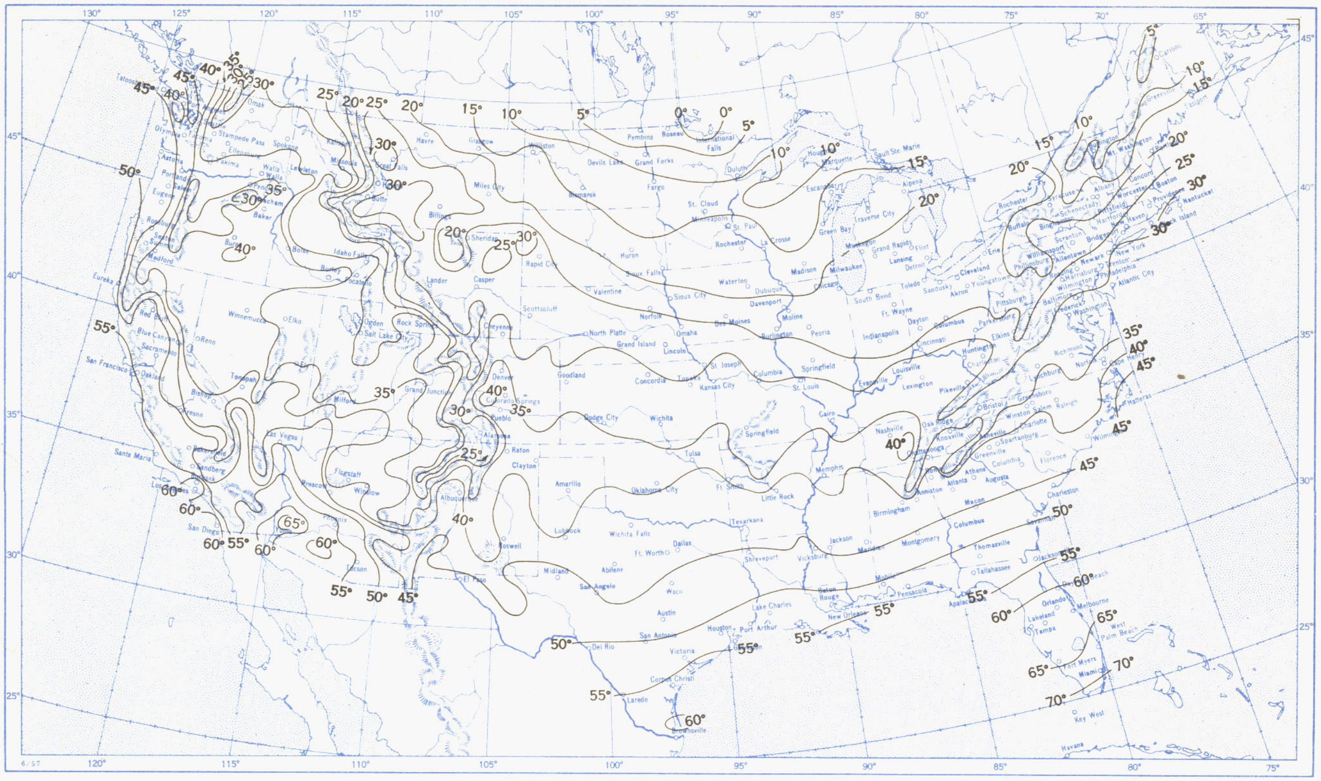
1. E. Paroczay, "The Weather and Circulation of November 1958—A Mid-month Reversal of Weather Regimes," *Monthly Weather Review*, vol. 86, No. 11, Nov. 1958, pp. 439–446.
2. W. H. Klein and J. S. Winston, "Geographical Frequency of Troughs and Ridges on Mean 700-mb. Charts," *Monthly Weather Review*, vol. 86, No. 9, Sept. 1958, pp. 344–358.
3. J. Namias, "The Annual Course of Month-to-Month Persistence in Climatic Anomalies," *Bulletin of the American Meteorological Society*, vol. 33, No. 7, Sept. 1952, pp. 279–285, and an unpublished extension through 1954.
4. U.S. Weather Bureau, *Historical Weather Maps, Northern Hemisphere, Sea Level*, January 1899–June 1939, Washington, D.C. 1943. (See December 1917).

NOTICE

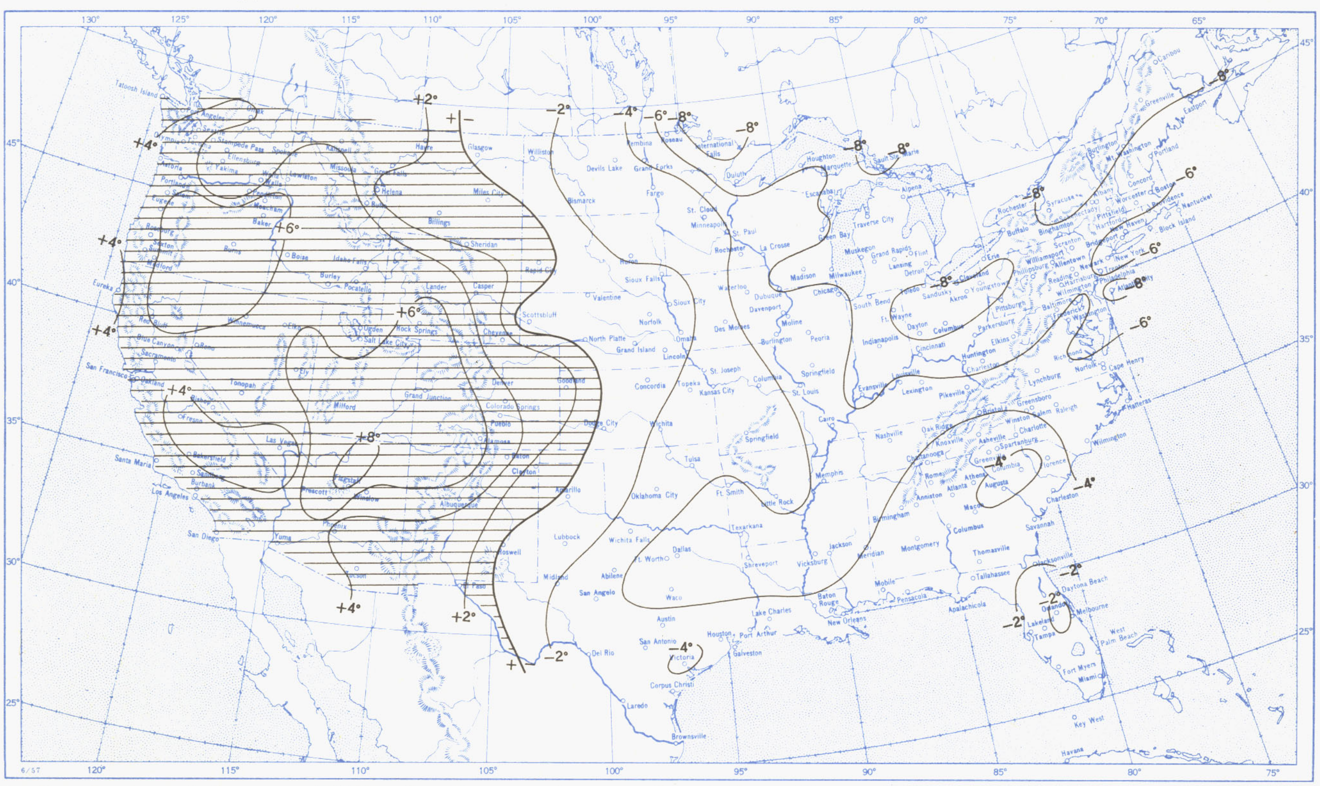
This is the last issue of the *Monthly Weather Review* in which the following climatological charts will appear. They will continue to be printed in *Climatological Data, National Summary.*

U. S. GOVERNMENT PRINTING OFFICE: 1959

Chart I. A. Average Temperature (°F.) at Surface, December 1958.

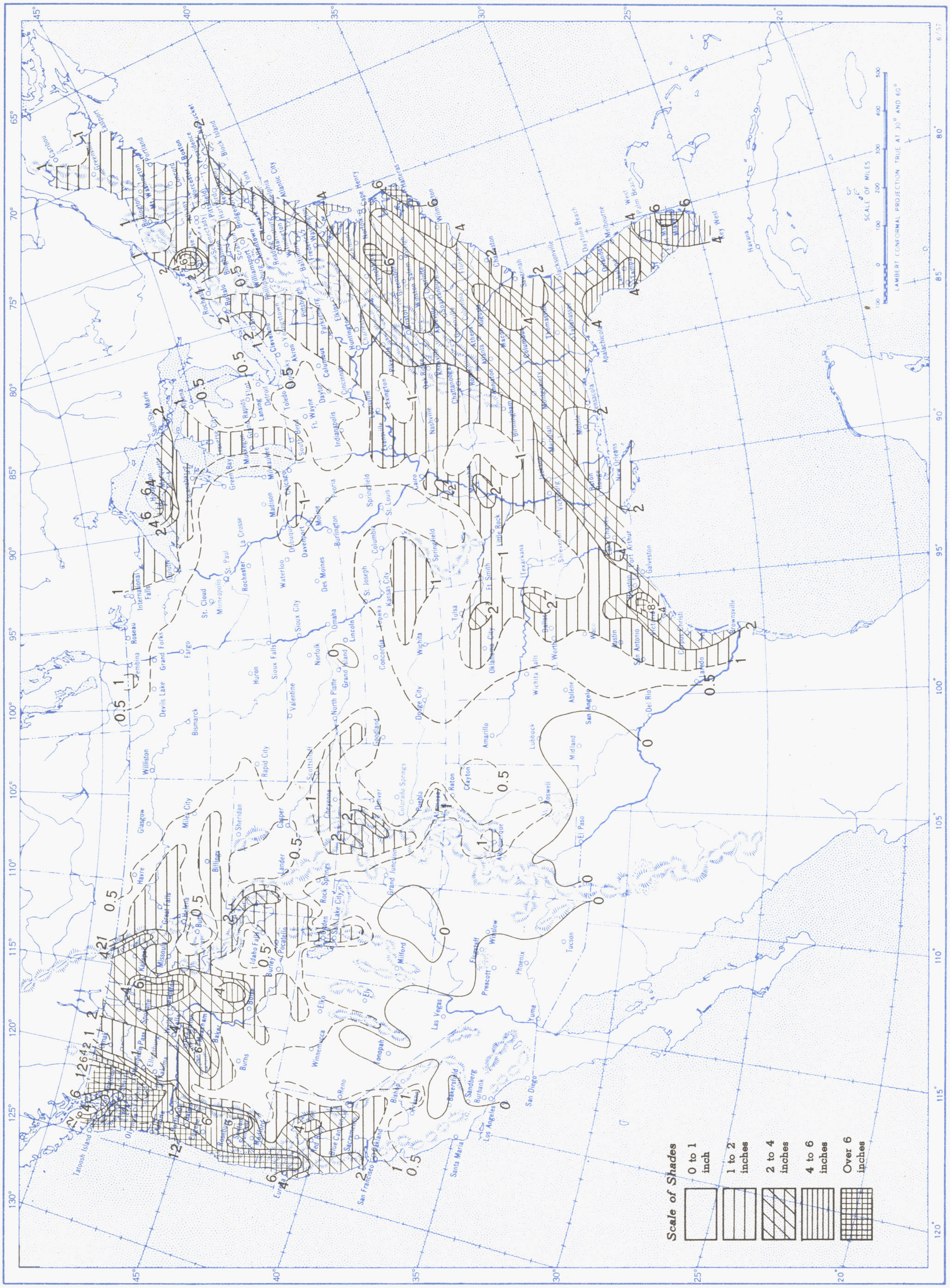


B. Departure of Average Temperature from Normal (°F.), December 1958.



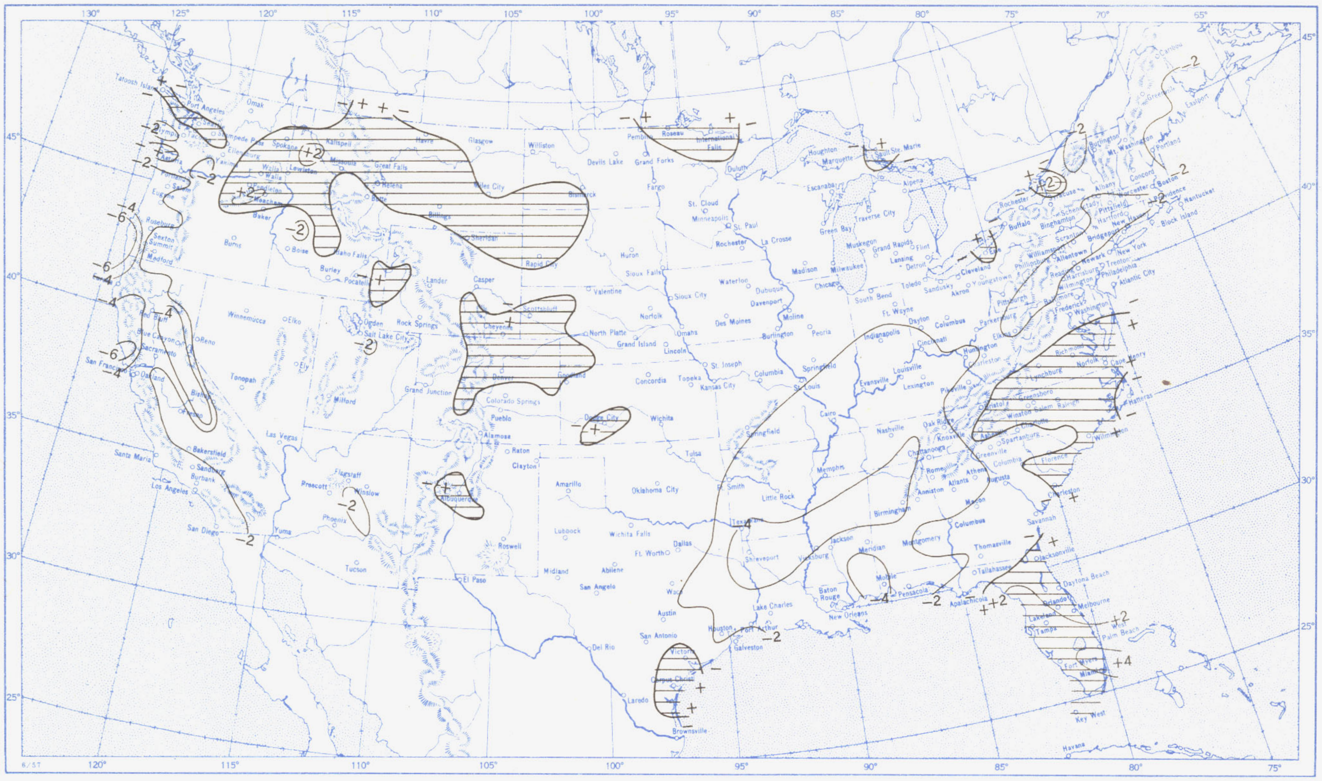
A. Based on reports from over 900 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.
B. Departures from normal are based on the 30-yr. normals (1921-50) for Weather Bureau stations and on means of 25 years or more (mostly 1931-55) for cooperative stations.

Chart II. Total Precipitation (Inches), December 1958.

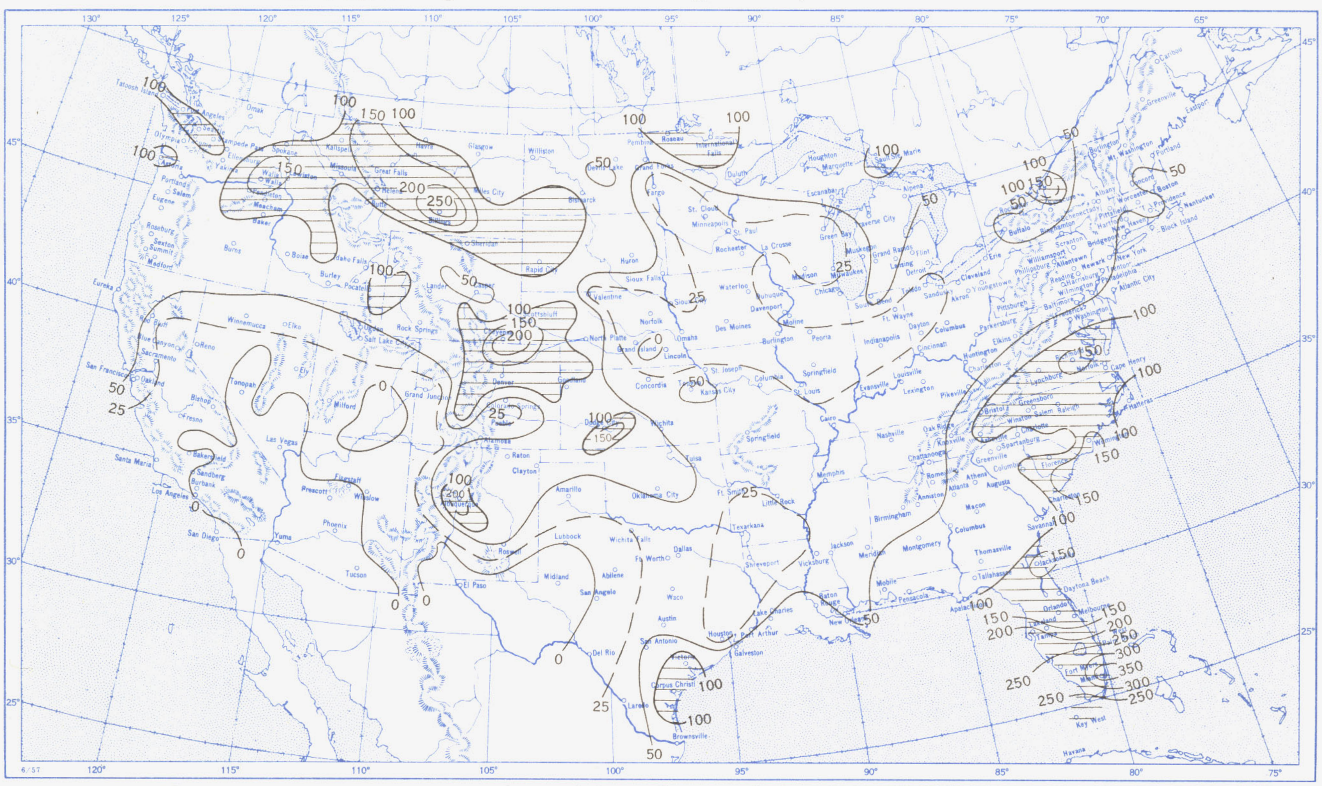


Based on daily precipitation records at about 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), December 1958.



B. Percentage of Normal Precipitation, December 1958.

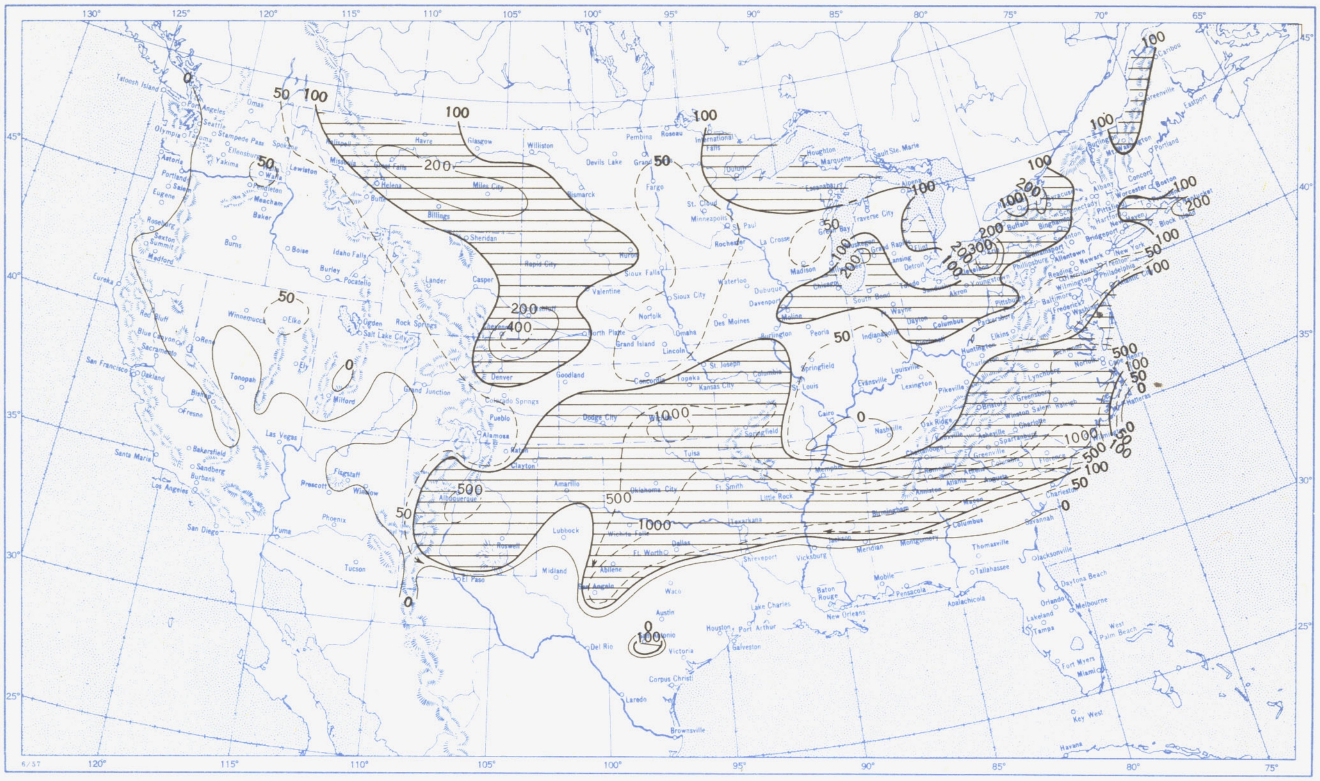


Normal monthly precipitation amounts are computed from the records for 1921-50 for Weather Bureau stations and from records of 25 years or more (mostly 1931-55) for cooperative stations.

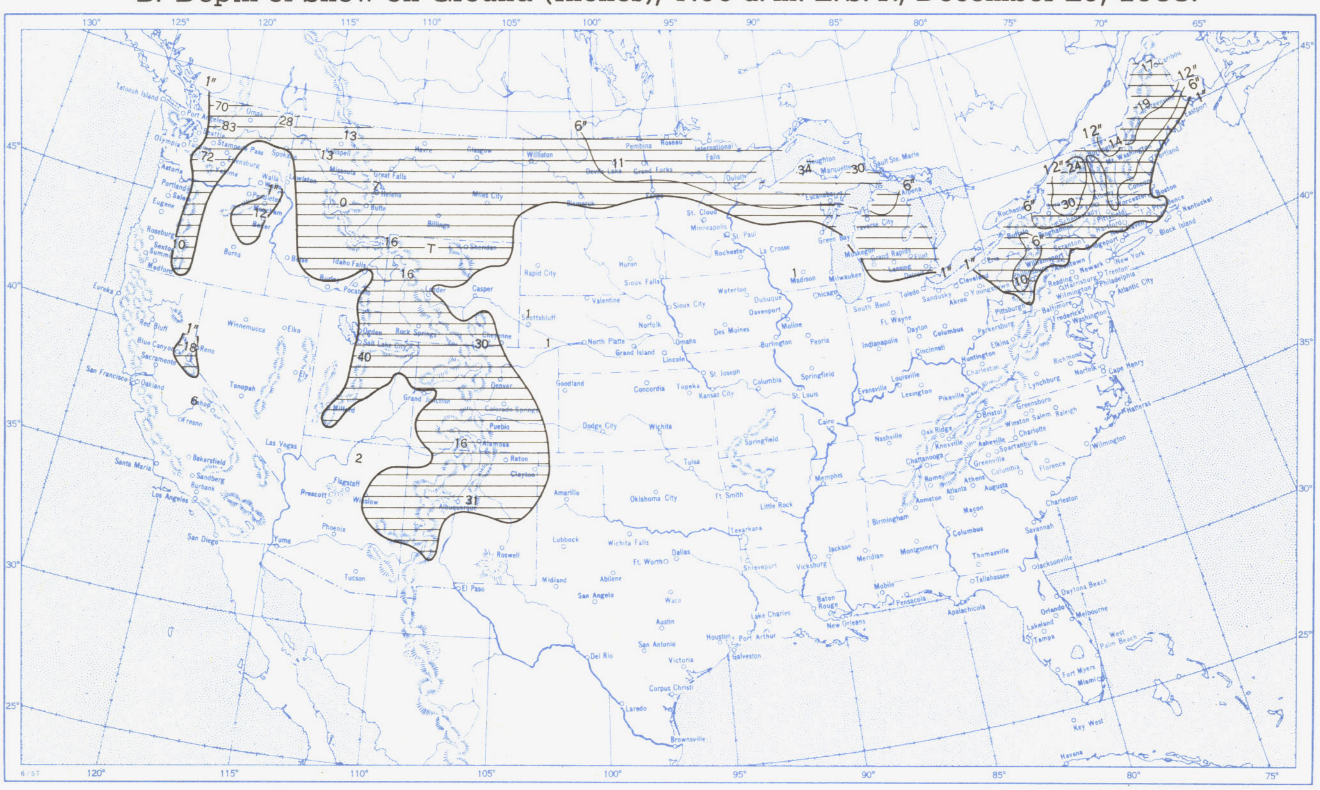
Chart IV. Total Snowfall (Inches), December 1958.

This is the total of unmelted snowfall recorded during the month at Weather Bureau and cooperative stations. This chart and Chart V are published only for the months of November through April although of course there is some snow at higher elevations, particularly in the far West, earlier and later in the year.

Chart V. A. Percentage of Normal Snowfall, December 1958.

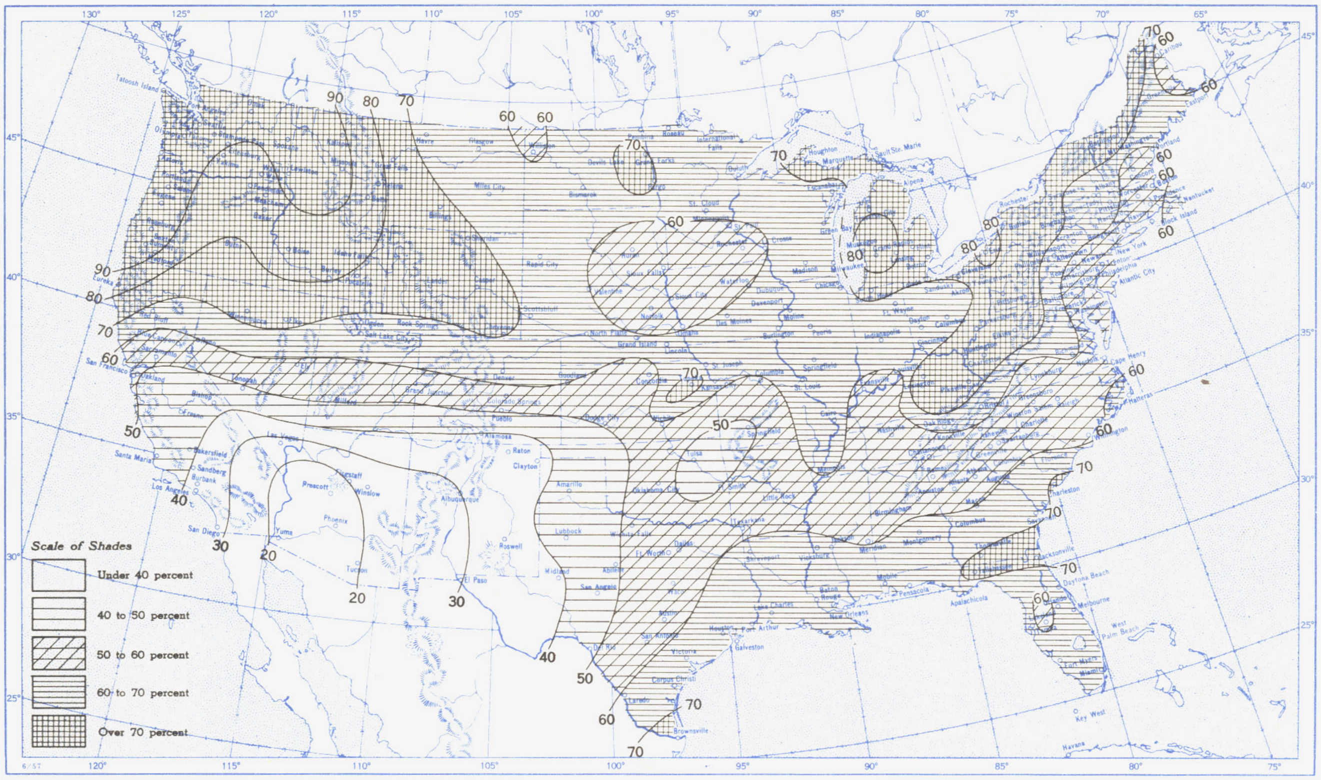


B. Depth of Snow on Ground (Inches), 7:00 a. m. E. S. T., December 29, 1958.

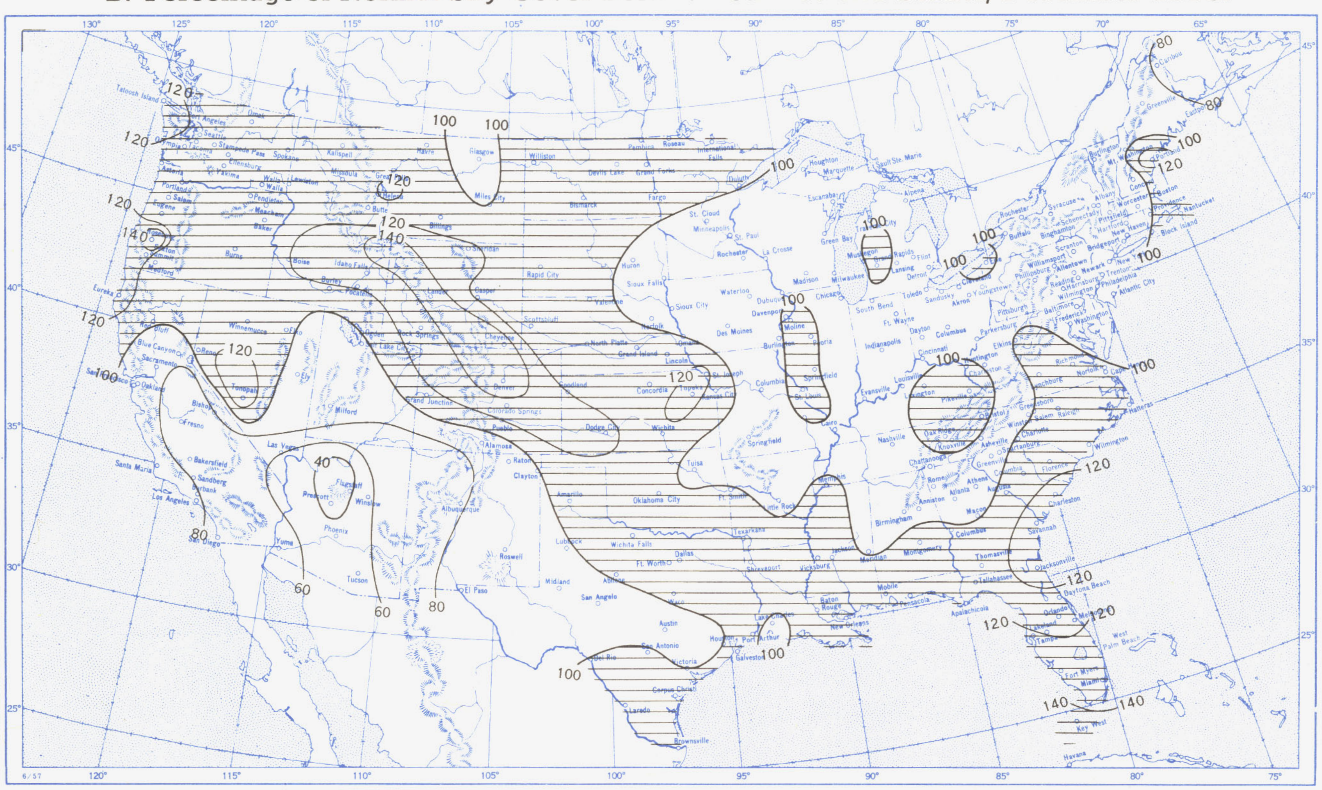


A. Amount of normal monthly snowfall is computed for Weather Bureau stations having at least 10 years of record.
B. Shows depth currently on ground at 7:00 a. m. E. S. T., of the Monday nearest the end of the month. It is based on reports from Weather Bureau and cooperative stations. Dashed line shows greatest southern extent of snowcover during month.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, December 1958.

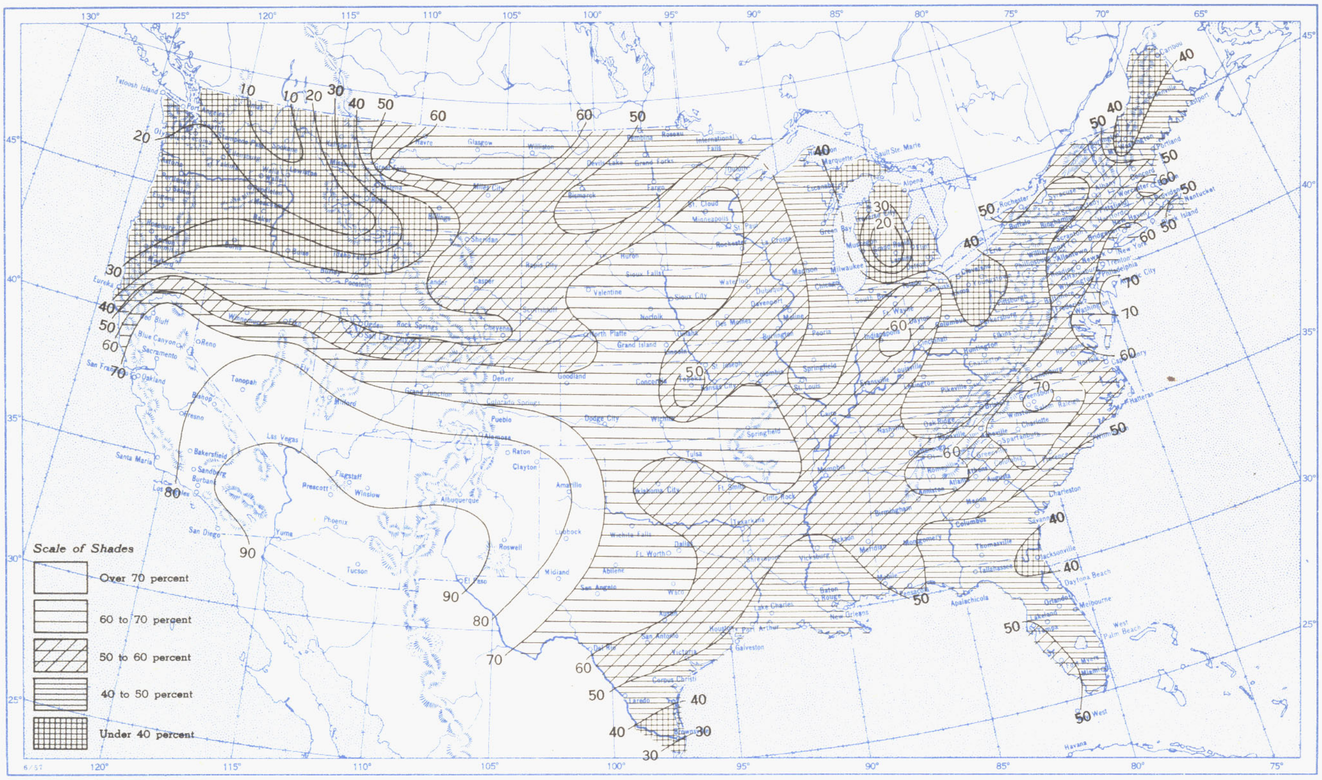


B. Percentage of Normal Sky Cover Between Sunrise and Sunset, December 1958.

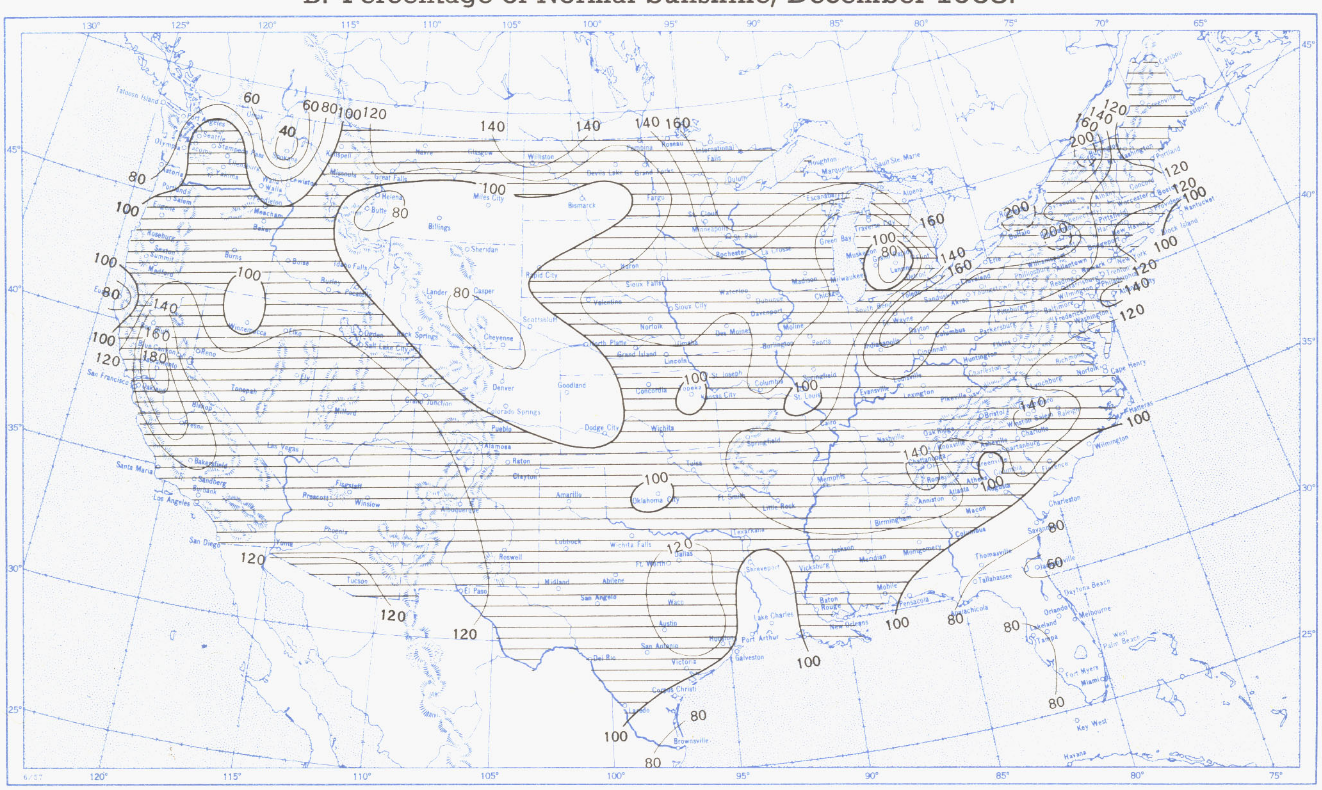


A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.

Chart VII. A. Percentage of Possible Sunshine, December 1958.



B. Percentage of Normal Sunshine, December 1958.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.

Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, December 1958. Inset: Percentage of Mean Daily Solar Radiation, December 1958. (Mean based on period 1951-55.)

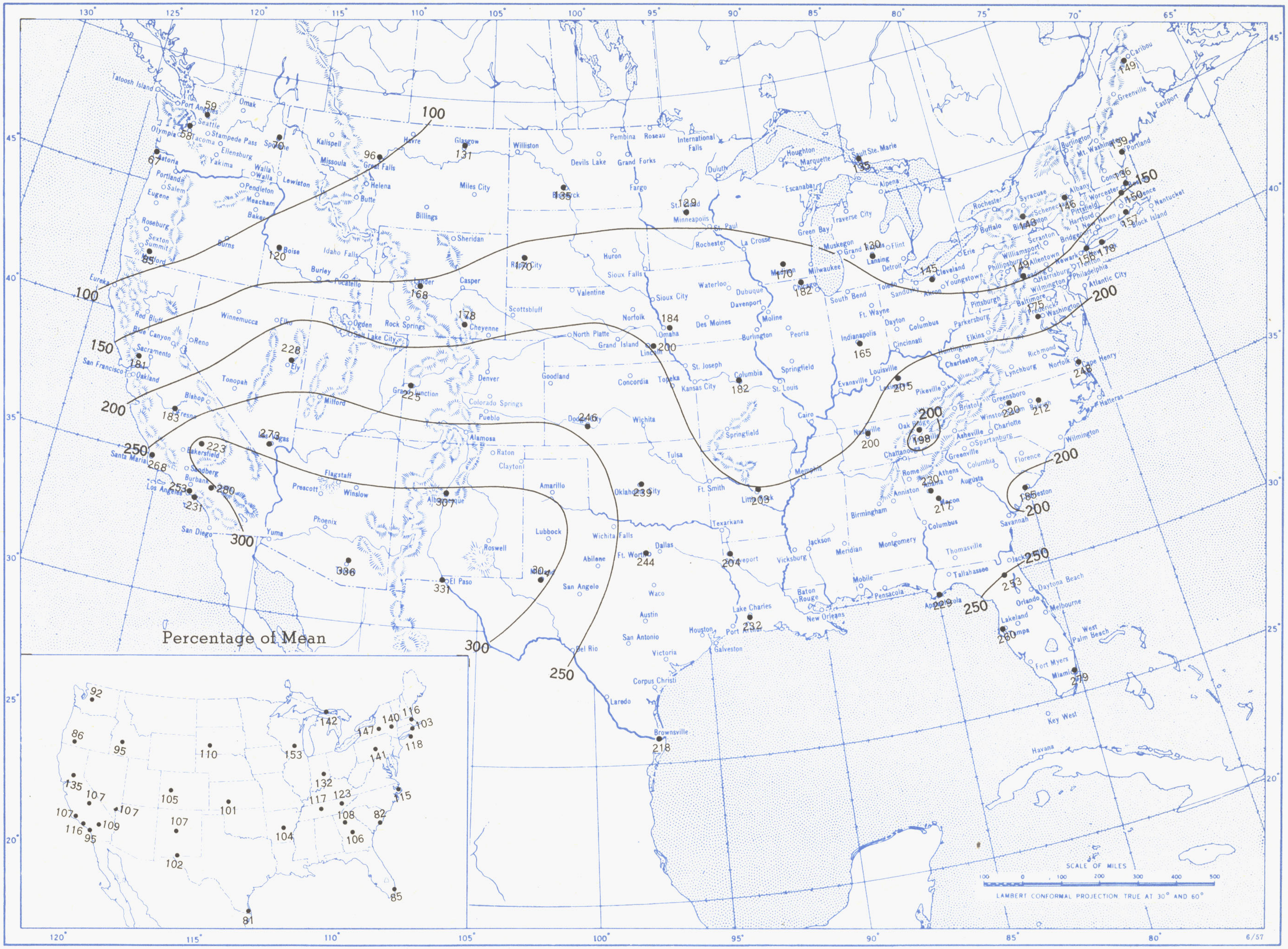
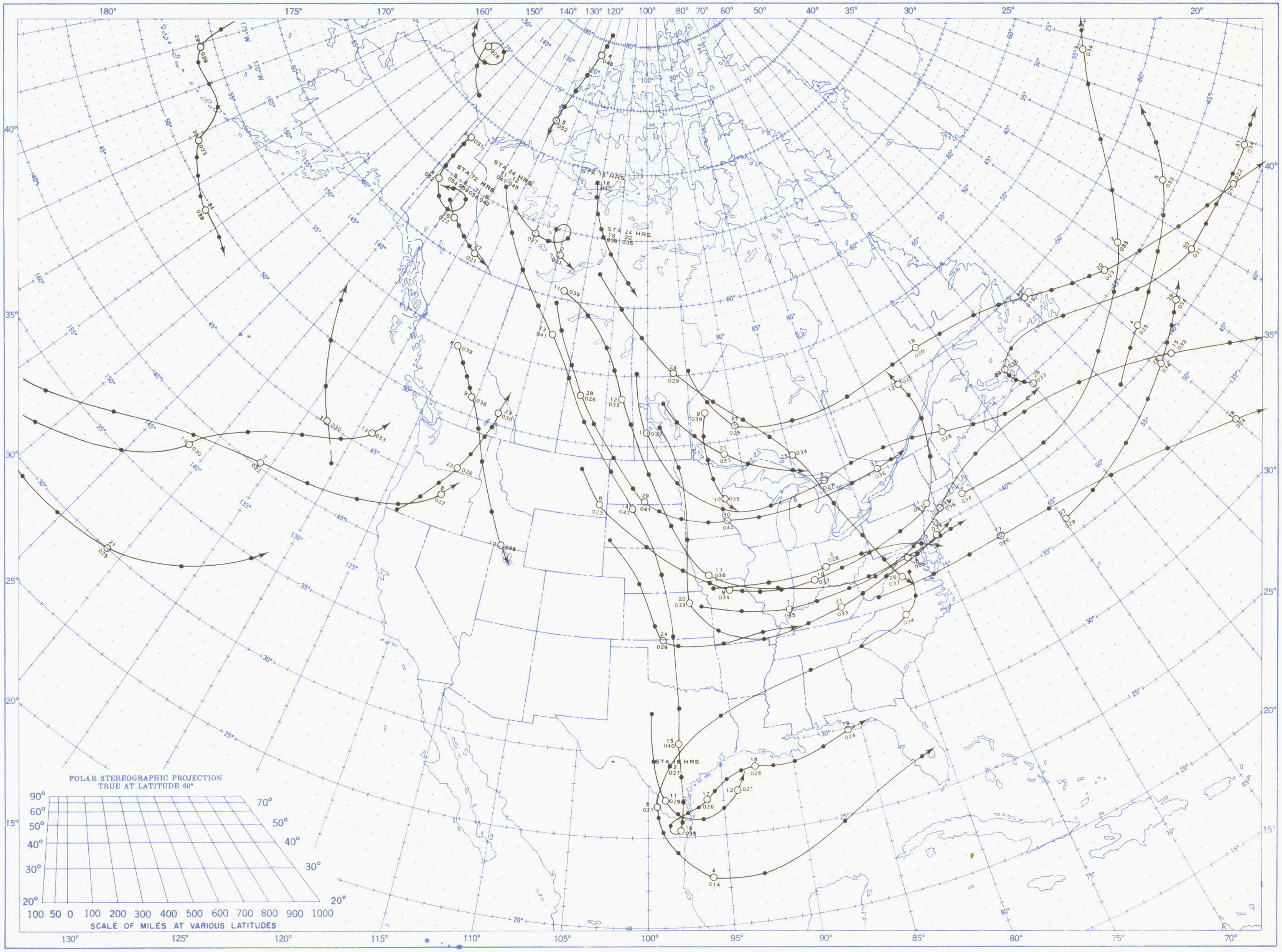


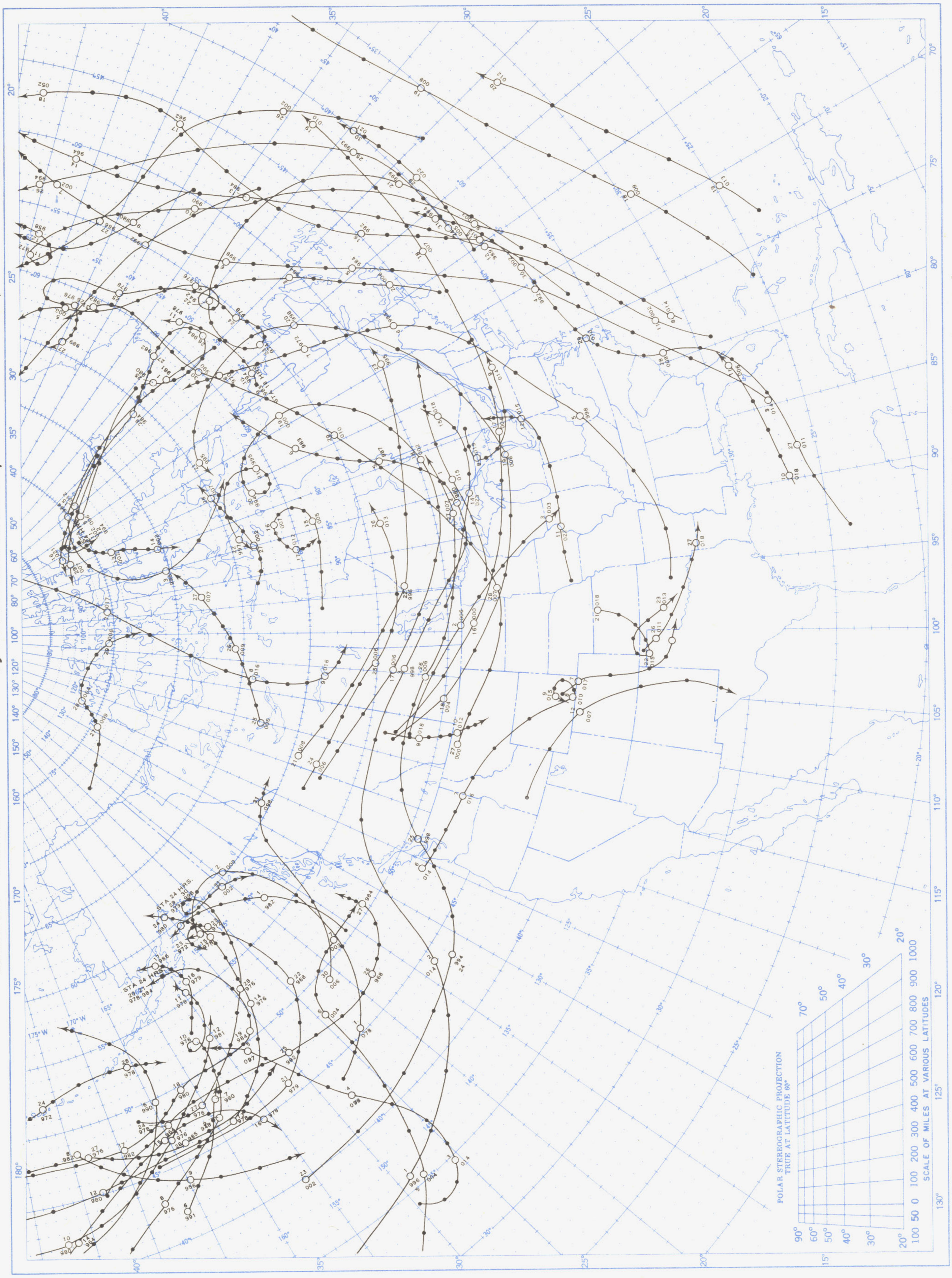
Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langleys (1 langley = 1 gm. cal. cm.$^{-2}$). Basic data for isolines are shown on chart. Further estimates are obtained from supplementary data for which limits of accuracy are wider than for those data shown. The inset shows the percentage of the mean based on the period 1951-55.

Chart IX. Tracks of Centers of Anticyclones at Sea Level, December 1958.



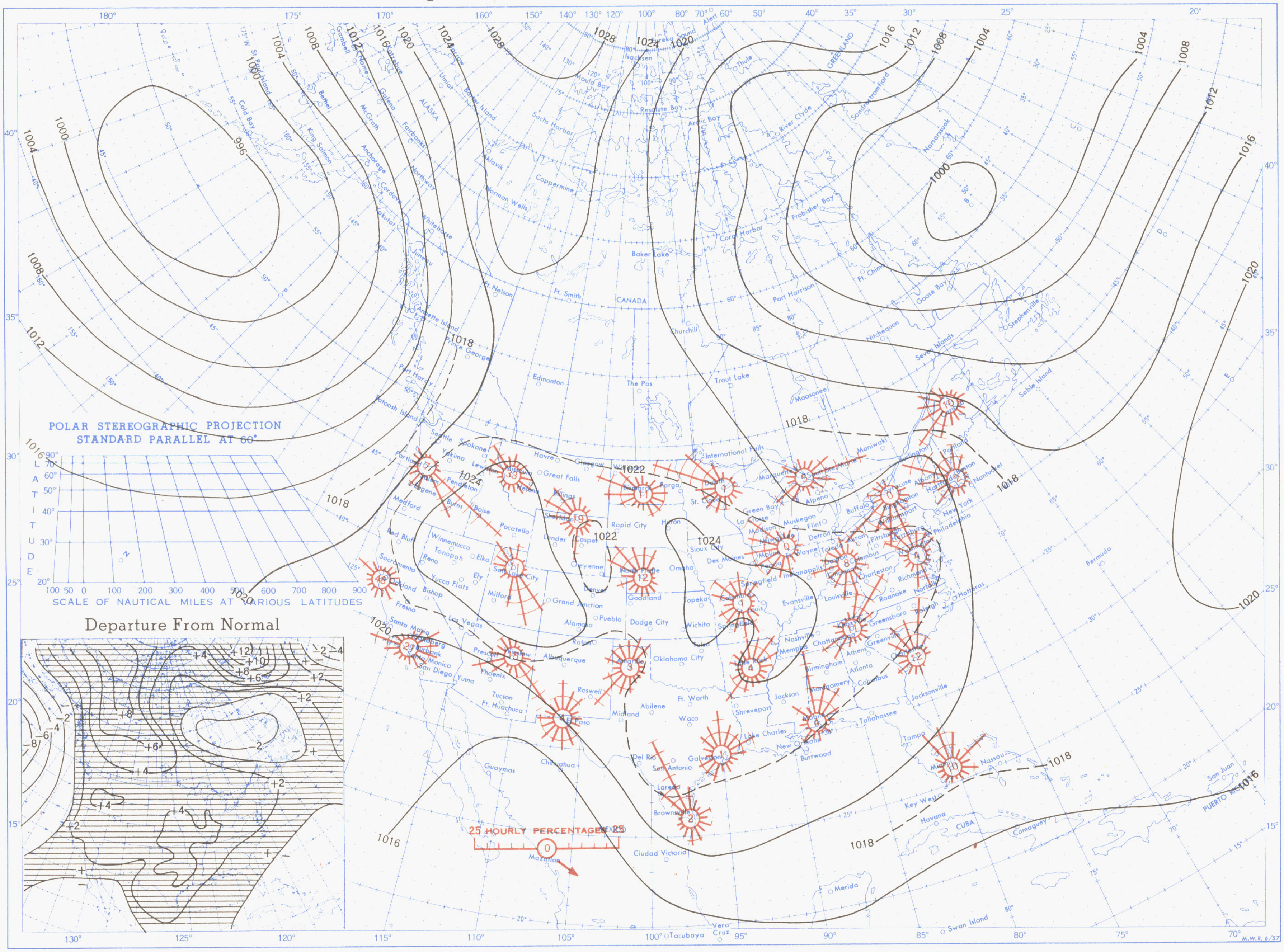
Circle indicates position of center at 7:00 a. m. E. S. T. Figure above circle indicates date, figure below, pressure to nearest millibar. Dots indicate intervening 6-hourly positions. Squares indicate position of stationary center for period shown. Dashed line in track indicates reformation at new position. Only those centers which could be identified for 24 hours or more are included.

Chart X. Tracks of Centers of Cyclones at Sea Level, December 1958.



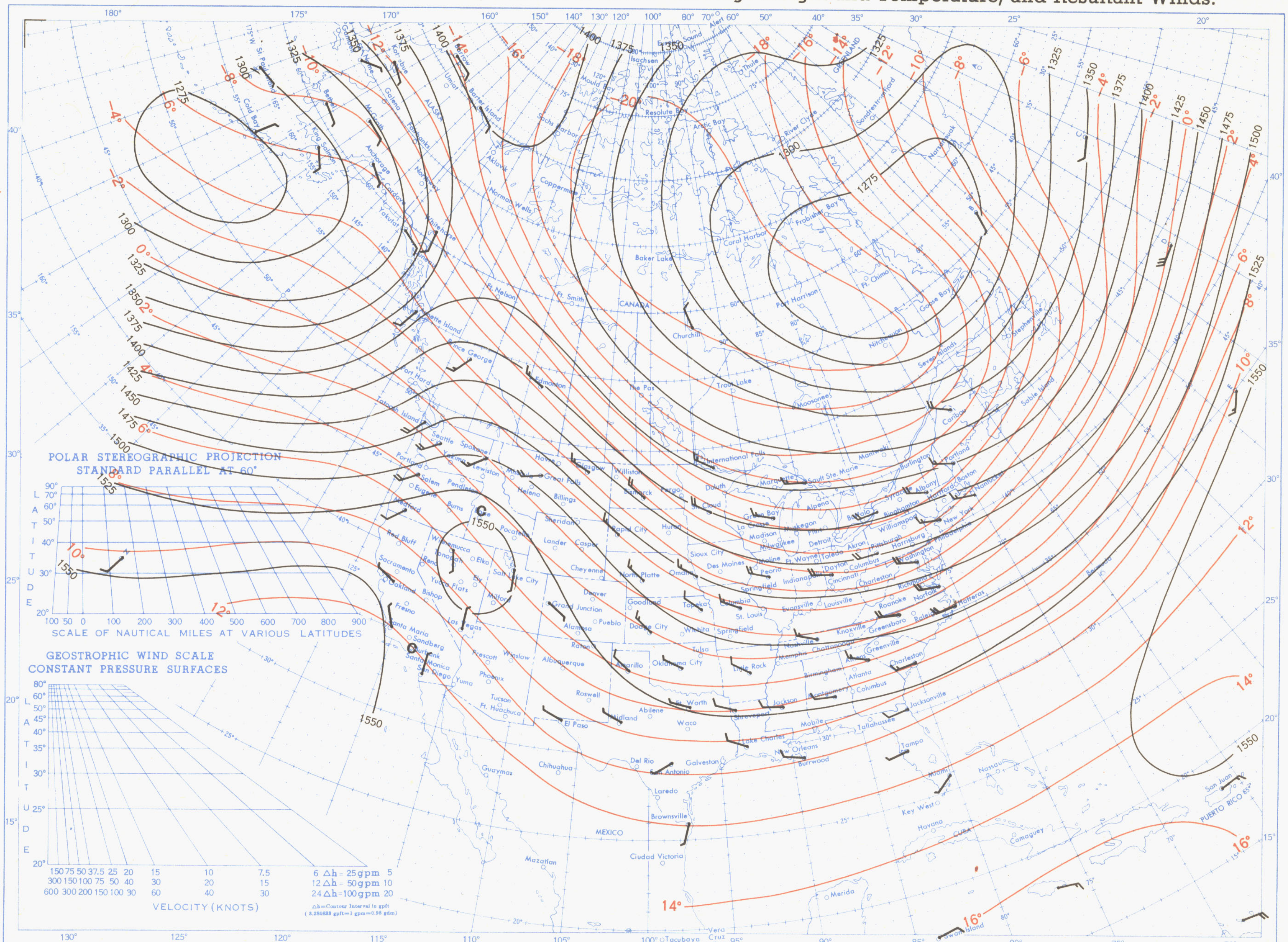
Circle indicates position of center at 7:00 a.m. E. S. T. See Chart IX for explanation of symbols.

Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, December 1958. Inset: Departure of Average Pressure (mb.) from Normal, December 1958.



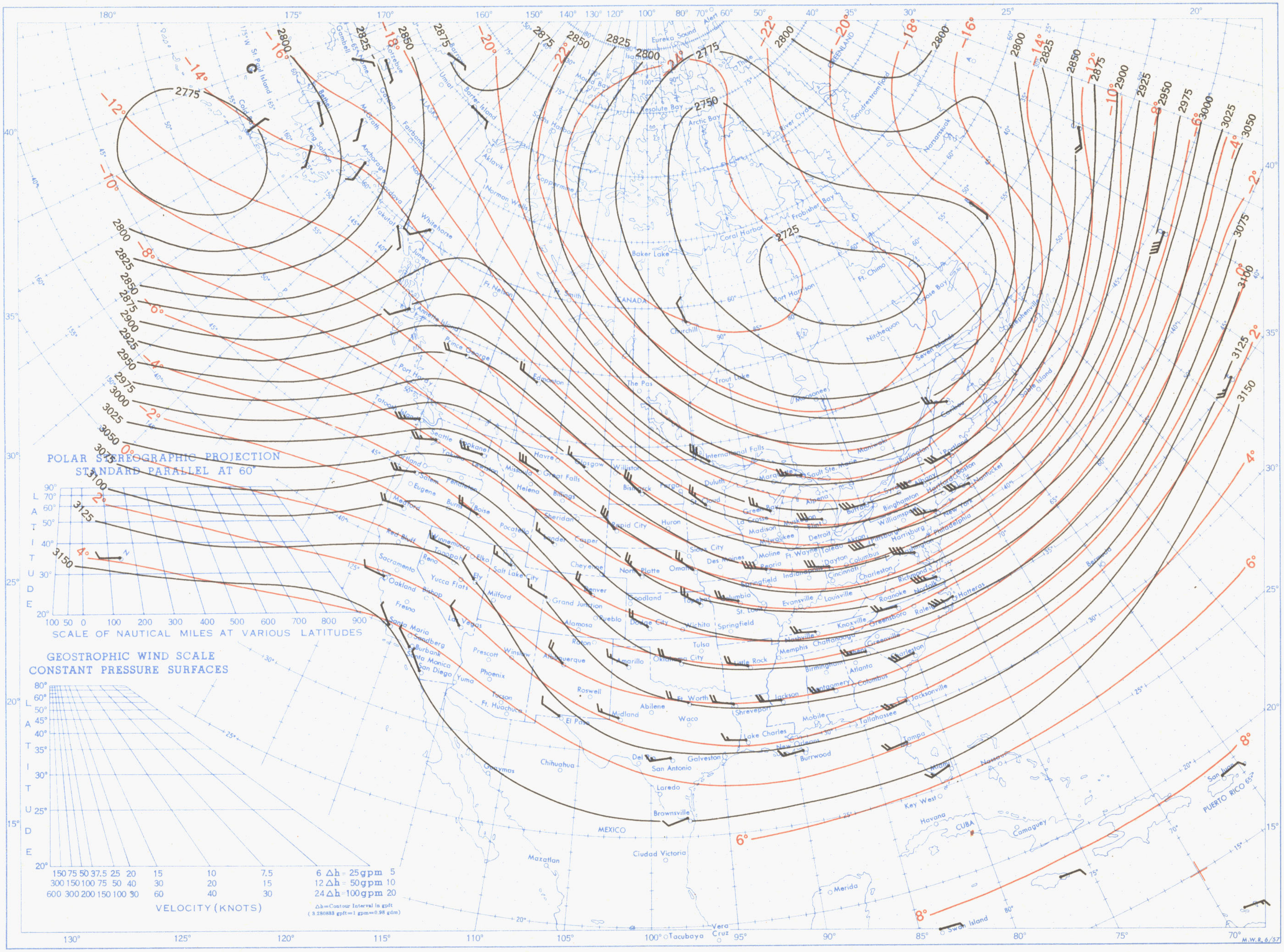
Average sea level pressures are obtained from the averages of the 7:00 a. m. and 7:00 p. m. E. S. T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° intersections in a diamond grid based on readings from the Historical Weather Maps (1899-1939) for the 20 years of most complete data coverage prior to 1940.

Chart XII. 850-mb. Surface, 1200 GMT, December 1958. Average Height and Temperature, and Resultant Winds.



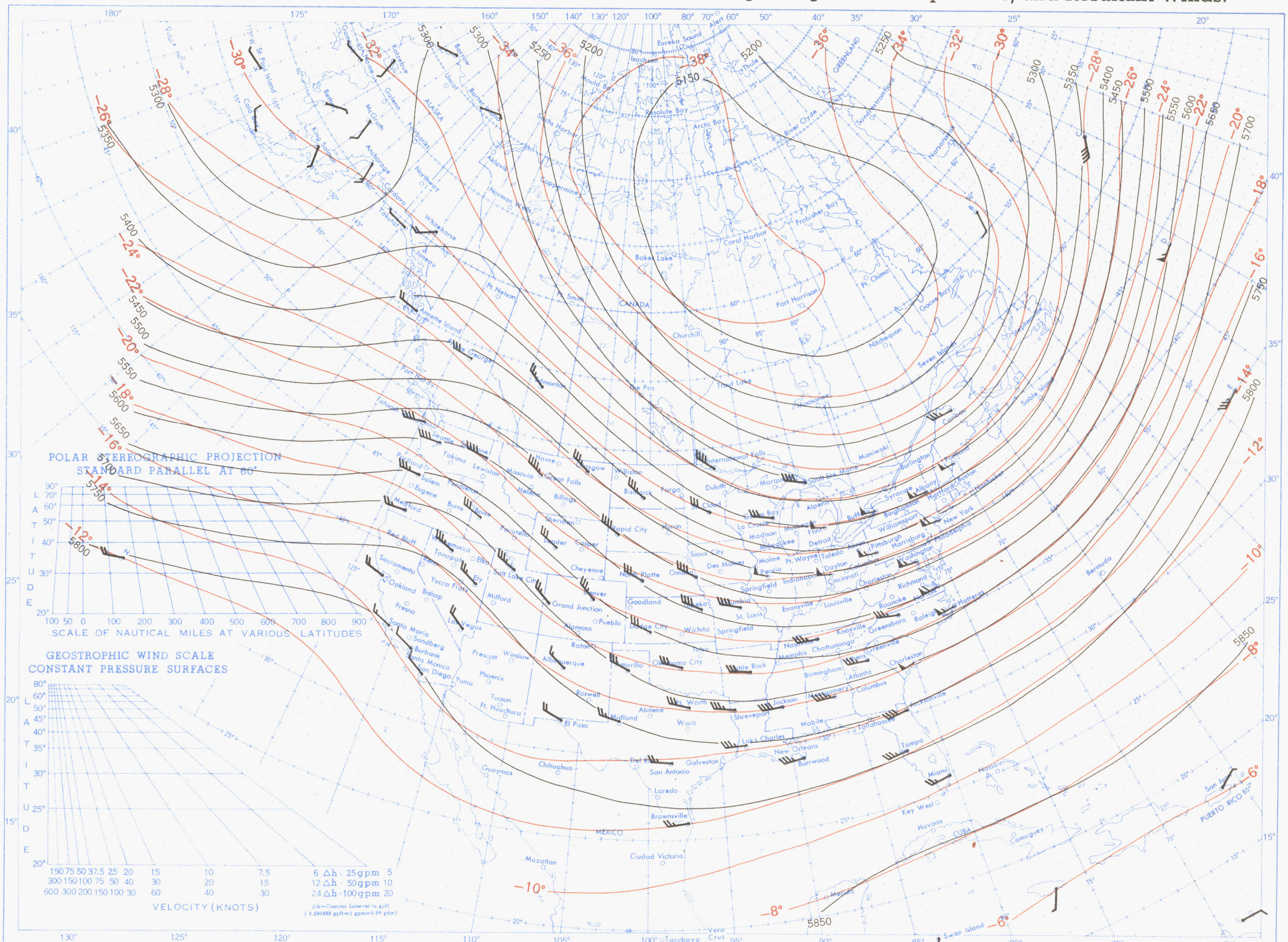
Height in geopotential meters (1 g.p.m. = 0.98 dynamic meters). Temperature in °C. Wind speed in knots; flag represents 50 knots, full feather 10 knots, and half feather 5 knots. All wind data are based on rawin observations.

Chart XIII. 700-mb. Surface, 1200 GMT, December 1958. Average Height and Temperature, and Resultant Winds.



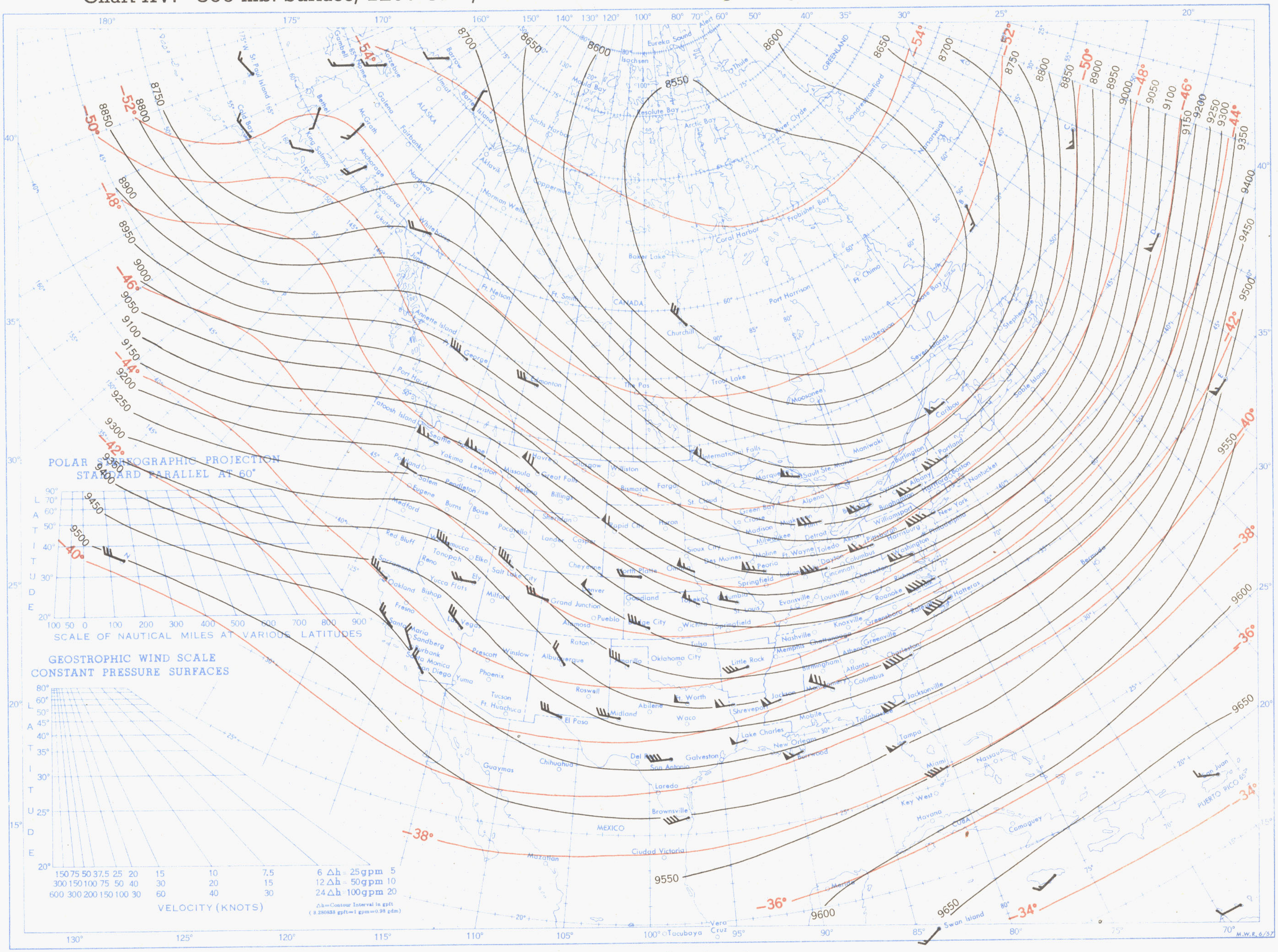
See Chart XII for explanation of map.

Chart XIV. 500-mb. Surface, 1200 GMT, December 1958. Average Height and Temperature, and Resultant Winds.



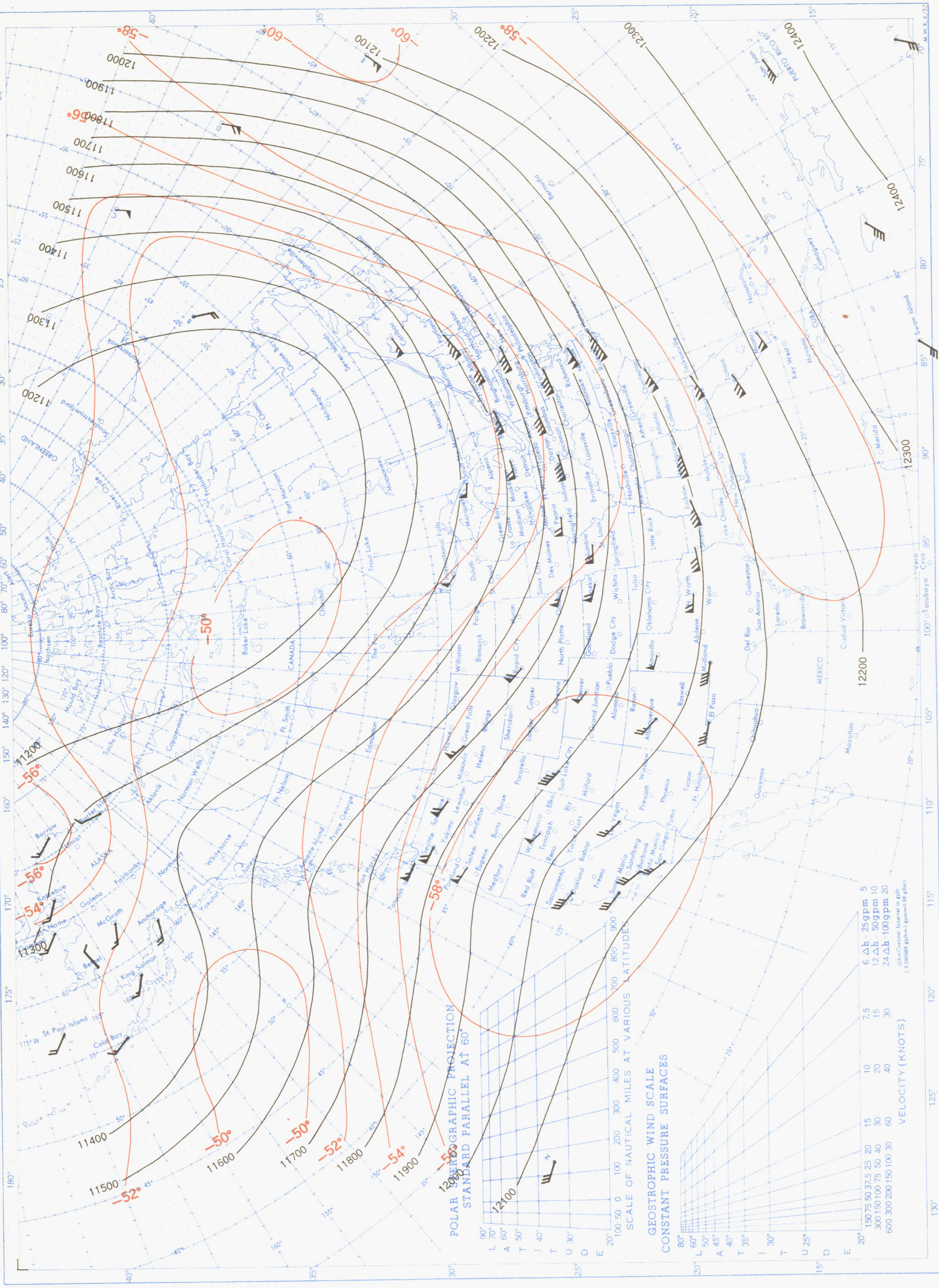
See Chart XII for explanation of map.

Chart XV. 300-mb. Surface, 1200 GMT, December 1958. Average Height and Temperature, and Resultant Winds.



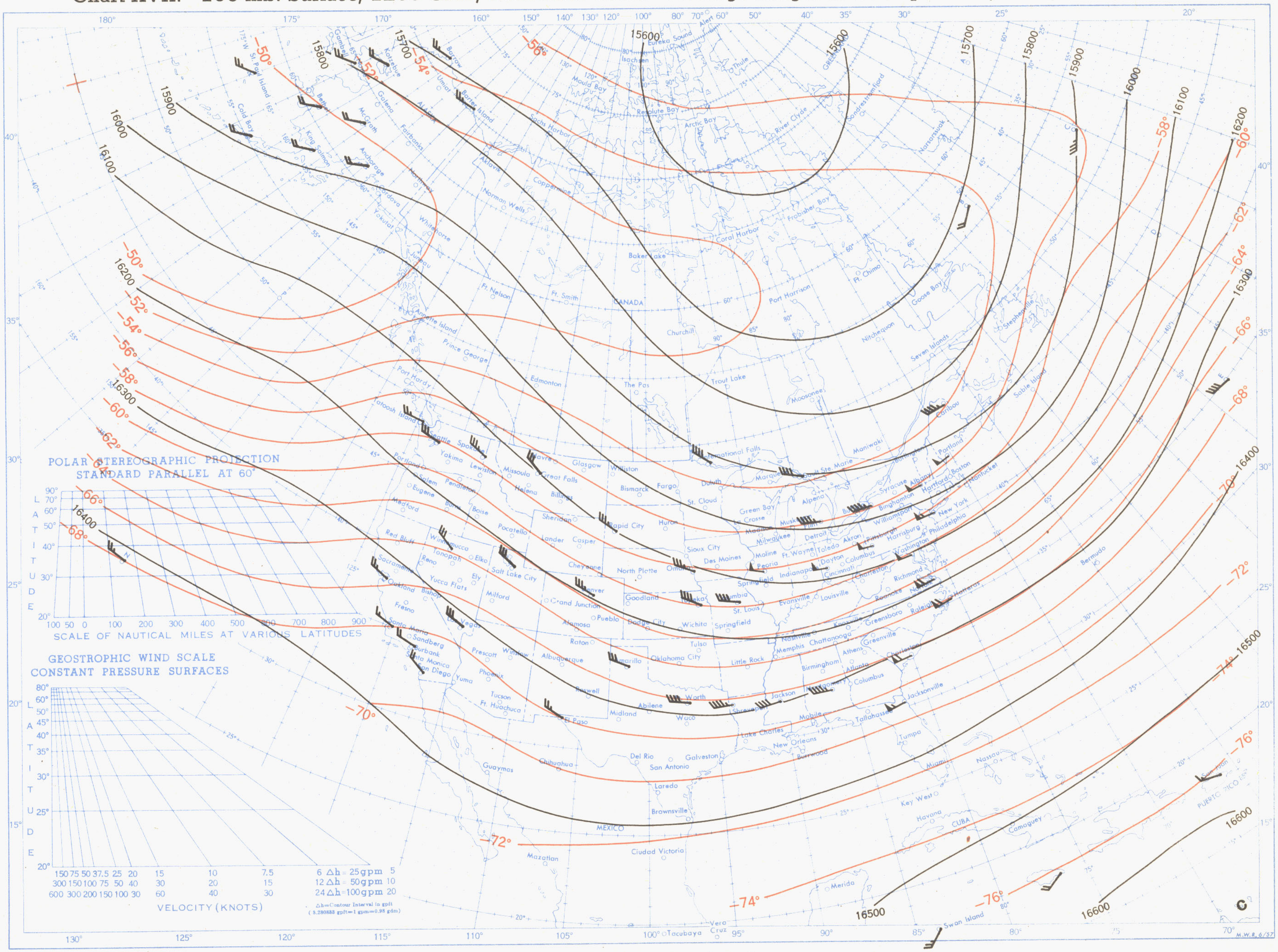
See Chart XII for explanation of map.

Chart XVI. 200-mb. Surface, 1200 GMT, December 1958. Average Height and Temperature, and Resultant Winds.



See Chart XII for explanation of map.

Chart XVII. 100-mb. Surface, 1200 GMT, December 1958. Average Height and Temperature, and Resultant Winds.



See Chart XII for explanation of map.